COLLINS
ACCOUNT AND ANALYSIS PRODUCTS ARE AVAILABLE IN THESE STYLES

“3880” SERIES ACCOUNT BOOKS
84 Leaf A4, Cased-In Red Oyster Covers
10949 Day Book – Paged
10856 Journal – Paged
10863 Treble Cash – Paged
10870 4 Money Column
10877 5 Money Column
10884 6 Money Column
10891 7 Money Column
10898 Double Ledger – Paged & Indexed
10905 Minute – Paged
10912 Minute Index – Paged
10919 Feint – Paged
10926 Indexed Through

10940 3 Quire Feint
10947 4 Quire Feint

“61” SERIES ANALYSIS BOOKS
84 Leaf A4, Cased-In Green Oyster Covers
13061 8 Money Column
13068 9 Money Column
13075 10 Money Column
13082 11 Money Column
13089 12 Money Column
13096 13 Money Column
13103 14 Money Column
13110 15 Money Column
13117 16 Money Column
13124 17 Money Column
13131 18 Money Column
13138 Petty Cash, 2 Credit & 11 Debit Columns

“700” SERIES ANALYSIS BOOKS
96 Leaf A3.5 (297 x 315), Cased-In Forest Green Covers
13259 24 Money Column
13266 27 Money Column
13273 32 Money Column
13287 Petty Cash 3 Credit & 17 Debit Columns
13280 Petty Cash 4 Credit & 9 Debit Columns
13294 Petty Cash 4 Credit & 16 Debit Columns
13301 Feint Only

“800” SERIES ANALYSIS BOOKS
96 Leaf A3 (297 x 420), Cased-In Forest Green Covers
13238 24 Money Column
13245 27 Money Column
13252 32 Money Column

ANALYSIS PADS
A3 (297 x 420)
23122 12 Money Column
23129 13 Money Column
23136 14 Money Column
23143 18 Money Column
A3.5 (297 x 630)
23157 24 Money Column
23164 27 Money Column
23171 32 Money Column

“4394” SERIES ACCOUNT BOOKS
4 Quire (192 leaves), A4, Sewn Sections
Quarter Bound with Half Rough Sheepskin Leather
11110 Journal – Paged
11116 Minute – Paged
11122 Feint – Paged

“A24” SERIES BOOKS
A4, 24 Leaves, Stapled
Account Books – Red Cover
10200 Feint
10201 Day
10202 Journal
10203 3 Money Column (Treble Cash)
10204 4 Money Column
10230 Double Ledger
10232 Minute
Analysis Books – Green Cover
10208 8 Money Column
10210 10 Money Column
10212 12 Money Column
10213 13 Money Column
10214 14 Money Column
10218 18 Money Column

ACCOUNTANTS BOOK
A Small Business Aid to Accounting – Blue Cover
10240 A24 Series A4

“A60” SERIES BOOKS
A4, 60 Leaves, Sewn Sections
Account Books – Red Cover
10305 Feint
10301 Day
10302 Journal
10303 3 Money Column (Treble Cash)
10304 4 Money Column
10330 Double Ledger
10332 Minute
10334 Indexed Through
Analysis Books – Green Cover
10308 8 Money Column
10310 10 Money Column
10312 12 Money Column
10313 13 Money Column
10314 14 Money Column
10318 18 Money Column

ACCOUNTING PAPERS
A3 Fly (Folded to A4) 120 sheets
10100 Feint
10130 Double Ledger
10102 Journal
10103 3 Money Column (Treble Cash)
10113 13 Money Column Analysis
10114 14 Money Column Analysis

A Spicers Product
<table>
<thead>
<tr>
<th></th>
<th>A1</th>
<th>A2</th>
<th>A3</th>
<th>A4</th>
</tr>
</thead>
<tbody>
<tr>
<td>AxLO</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>AxHi</td>
<td>600</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AxHy</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>AxTE</td>
<td>0.5</td>
<td>0.5</td>
<td>0</td>
<td>0.5</td>
</tr>
<tr>
<td>AxRT</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Axno/mc</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>AxSP/61</td>
<td>SP</td>
<td>SP</td>
<td>SP</td>
<td>SP</td>
</tr>
</tbody>
</table>

P. Set | 0 |
Bi-9T | 15 |
dull | 6 |
RE- | 0 |
RE+ | 700 |
Chn0 | CAL1 |

In CAL mode:
dend | 1 |
dCPT | 0 |
fltr | 3 |
RATE | 10 |
RANGE | 2.5 |

1/3 RPM:
1. SPAC | 2. none | 3. none
Print | none |
SPAC | A1-2 |
ECAL | 2.030 |
ESCL | 700 |
OFF | Set F 200 |

In REMOTE:
LOCAL wiring OK.
**Setting up Pressure Transducers**

**Erich Brosa Serial No. 983255**

<table>
<thead>
<tr>
<th>Relay</th>
<th>Action</th>
<th>Recheck Status</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pump up</td>
<td>300</td>
<td>300 MPa</td>
</tr>
<tr>
<td>2</td>
<td>Bleed</td>
<td>300</td>
<td>300 MPa</td>
</tr>
<tr>
<td>3</td>
<td>Max P 600 MPa</td>
<td>300</td>
<td>300 MPa</td>
</tr>
<tr>
<td>4</td>
<td>Doorbolts</td>
<td>300</td>
<td>300 MPa</td>
</tr>
</tbody>
</table>

Hydr. Test: Rp

<table>
<thead>
<tr>
<th>Test</th>
<th>Status</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>10 0 0</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>1 0 0 0</td>
</tr>
</tbody>
</table>

Doorbolt control works.

Local Bleed & pump work on manual & automatic & remote.

Began testing.

200 MPa required; 300 tightened. Then holding 100 MPa ok.

Pumped again. Booster to 100 MPa, intensifier to 300 MPa.

Insufficient pressure going back at 71 MPa; stopped here, with oil valve open.

Oil connection from tank to sight glass no good.

Put grease in bleed holes of plumbing & tags on tanks.

Plumbing supports are blocking some bleed holes.

Pressure gauge connection was leaking & only connected.

Pumped to 500 MPa. Slow leak > 1 MPa per minute.

550
600
700

A3 enabled light comes on at 600 MPa. (A2 is set at 620 MPa & A3 at 600 MPa but bleed control is in REMOTE?)

Load pump as the pump cuts in at 600 MPa.

Back to 500 MPa. Holding tight ½ hr. No obvious plumbing leaks.
3-Point mic. up by 0.010 to 0.020 after 740 MPa

0.11 kPa, 500 kPa
-0.035 same

60°: -0.010 740 kPa
120°: -0.005

80°: 0.050 same
-0.034
-0.022

Top stretch is at least 0.010
Bottom stretch is about 0.027

Dual gauge 0.000
Seine 12 grado
Pressure-testing Pressure Vessel

Pressure and finally arrived from Bishops around 7:30. Drug seal seats had to be polished.
Safety cooling sleeve was put on and coils wound last week. Still no bubble tubes.

26/2/99

Bubbles tubes now fitted. (intensifier oil cylinder had to be drilled; missed before)
Top blank plug repolished by Andy who said it leaked.
Bob said to be out-of-round on 865 by 0.030; could be bit more
Gas leak to 100 Mla — bubble at 603.
Connected with intensifier to 500 Mla.
Slight leak — oil leak at entry to gauge — not seating on seal.
Fixed.
Pumped to 600 Mla

*NOTE: The control is effective on MANU by
intensifier

When bleeding (remote) pump stopped at A3 alarm.
{or local}

Pressure = 600

A3 alarm on (both local & remote)

Anti-water drain — furious leak

Pressure to 680 Mla, leaking at pump rate.
Climing down, leak started at 480 Mla at ~ 450 Mla.
Stopped at 260 Mla — glass transition.
No 3 was leaky at ~ 800 Mla, stopped at 160 Mla.
Leak at entry to pressure gague. Tightened.
Pumped again to just over 700 when rupture disk in oil tank went.
Need closer fitting plugs around furnace leads.

Gas booster a bit erratic - pressure sticking at 3-5 bar.

Door unlocked when power off.
1/3/99

Pressure taken up to 740 MPa, held quite well. On dropping down slowly, still yielding a "glow transition" leak at 4. Then at 3, at ~370 MPa. Stopped finally at 156 MPa.

3/3/99

Setting up for temperature run.
Heat through on brass connector blocks.
Introducing tool did not get furnace plug. Audy chased threads.
Can't find manual for 933 controller.
Short PS2 pistons are 42 mm — have to be made 30 mm.

Set up calib assembly with 2 x 30 + 1 x 126 mm alumina.
Had to drill out bottom filler to accommodate it.

The traverse has to be adjusted to range.

4/3/99

Trying to get T/C 1/2 to read sensibly.
Phil re-wired the T/C connecting cable. Now right polarity.
But A/C meter reads 308 when Eurotherm reads 318 °
° 301 ° 273

Behind A/C meter, $T = \frac{326}{\theta}C = \frac{326}{0.305.6} \approx 306.1$ when cold junction reading is 306.1

Reset A/C to Type R Thermocouple.
New with Fluke reading of 4.67, A/C = 298, Euro = 300K
$\frac{299.9}{273.2} \approx 1.08K$

so at room temp, Eurotherm is OK & A/C reads -2K.

Connected up T/C, bubble etc & pumped up to 97 MPa.

Tried to run furnace but it turned out not to be connected.
Dropped p in vessel but left at 100 MPa in intensifier.
CONFIGURATION OF EUROTERM 903 TEMPERATURE CONTROLLER

(see configure p.395 to start)

dic 0300
PFb OFF
Hbr NONE

Typ Ramp r-P-rE (ramp set as rate)
Res Ramp 40

Uni Ramp 10 (minutes)
Uni Dwell 10 (minutes)

Set @ 20 in OPER

dic

3 → UConf
5 → sec
7 → 0
9 → IConf

A7 → C1 ▼ 0005
0
C2 0010
C3 0000
C4 1000
C5 3000
C6 0300
C7 0000
C8 0000
C9 1111
C10 0101

Idn 840 0044 [was 0004 in #.7]

1 → IConf 3 p20 leave ▼ → end

(Preload PID for control on top furnace TC was 20, 103, OFF)
Selling Up Furnace

Y3/3/59

Checked furnace resistances on top of stack throughs: 0.352 torr vacuum @ 0.55 cm center — these seem to be rather low!

But stack throughs to non-resistive TC's are open circuit.

Need handle on small plug & brush fixed on center power lead.

Pump (gas booster) sticking at ~20 MPa, 3.56 bar pressure; can

reset by switching off.

Pumped to 100 MPa.

Set OP on furnace to 100 with zero settings.

Then, in turn, wound partitioning pots to 100%, with fixed control on thyristors (full anticlockwise)

and wound up current control clockwise until current

in 15A (18.5A for bottom). Then immediately reduced

partitioning pot to zero.

Set PID = 5/80/20

Setings: 500/200/1000.

Pumped to 226 MPa.

SP = 400 K

OP at zero on MAN, RAMP/HOLD. Go to AUTO, & release

HOLD. OP went up to ~ 50; bottom current fell to 11A,

up to ~ 6 A.

T/C in Pt sheathed Pt/Rh, 308 mm long, in combined

profile/mix T/C. Put it at POS 4.

At end of ramp, T age to 412, 399, 400; OP ~ 35%; 241 MPa.

Turn SP to 700 K

Going up on ~ 60% OP, bottom current 12A, giving up to 13.3 A

Constant current K, at least 10

POS 0 1 2 3 4 5 6 7 8 9 10 11 12

5 96 657 689 701 705 706 705 701 689 662 616 557 506

798 789 697 608

Left on manual at OP = 627 (for ~10 min), back to OP = 62.5

634 704 710 753 756 756 755 752 740 711 660

-A V W 758 setting

T 63 10 63 500

C - - (200)

B 12.6 21.8 27.5 1880

\( \frac{338 \text{W}}{\text{K}} \) ≈ 0.70 W/K.
Need to check temperature logging.

When I come off MAN & release HOLD after temp profile, controller runs OP up to 100. When I just come off MAN & leave on RAMP/HOLD, controls properly. If later I press TA & remove ramp, controls OK. If now I make RAMP, OP goes down a bit & then up, but not steadily.
Buck ran to control & moved SP -> 900 K

4:43 end of ramp. T overshoot to 908.

12:15 T cycling up & down several K.

Self time at 1 left

\[
\begin{array}{ccccccc}
   & 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 & 11 \\
P = 10.9 & 120.0 & d = 36.7 \\
T & 768 & 856 & 868 & 901 & 900 & 899 & 902 & 907 & 869 & 804 & \ast \\
C & 300 & 5.7 & 10.2 & 7.0 & \text{op 68.2} & \text{op 68.2} & \text{op 68.2} & \text{op 68.2} & \text{op 68.2} & \text{op 68.2} \\
B & 1000 & 13.3 & 26.4 & 351 & \frac{422}{W} & 0.67 W/K & \ast & \ast & \ast & \ast \\
\end{array}
\]

Ramping to 5P 1200 on rpm T/C control at POS 4.

Overshot to 1210 K

Atlas for 2 hours: \( T = 1200 \) 1201 K

\[
\begin{array}{ccccccc}
   & 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 \\
P = 66.6 & \text{P = 332} \\
T & 500 & 6.5 & 1.4 & \text{OP} \\
C & 0 & \text{OP} \\
\end{array}
\]

Decreased settings to 500/500/800.

And put on ramp to 1300.

Some confusion in coming off baseline & OP was 100 for a while, putting T over 1300. AT end of ramp, T = 1327.

104 1211 1281 1297 1296 1300 1302 1302 128 1230 1119

\[
\begin{array}{ccccccc}
   & 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 \\
P = 340 MPa & \text{OP 63.2} \\
T & 500 & 6.1 & 11.0 & 9.8W & \ast & \text{OP} \\
C & 500 & 4.1 & 26.3 & 108 & \text{OP} \\
B & 1000 & 12.3 & 36.1 & \frac{444}{W} & 64.9 W & 0.63 W/K \\
\end{array}
\]

Put on ramp to 1500 & changed setting to 500/458/1000.

Lost power & had to go up again from ~800 K.

Before power loss, the power consumption was ~0.62 W/K.

Powered up again from ~800 K. Overshot to 1504 K. 355 MPa
Fair bit of backlash in hoist.
\[
\begin{bmatrix}
T & 500 & 6.8 & 20.2 & 137 \\
C & 450 & 4.5 & 26 & 117 \quad 783 \text{ W} \\
B & 1000 & 11.8 & 44.8 & 529 \\
\end{bmatrix}
\]

\[
\begin{aligned}
& \text{0 P 69.0} \\
& \text{P = 356/1714} \\
& 1268 \quad 1450 \quad 1514 \quad 1508 \quad 1497 \quad 1503 \quad 1572 \quad 1508 \quad 1450 \quad 1332
\end{aligned}
\]

**Changed to setting 450/550/1000**

\[
\begin{aligned}
& \text{0 P 67.3} \\
& \text{P = 35.4} \\
T & 450 & 5.8 & 17.2 & 100 \quad 745 \text{ W} \\
C & 550 & 4.3 & 31.7 & 136 \\
B & 1000 & 12.2 & 41.7 & 509 \\
\end{aligned}
\]

\[
\begin{aligned}
& 1212 \quad 1408 \quad 1488 \quad 1497 \quad 1498 \quad 1496 \quad 1494 \quad 1488 \quad 1466 \quad 1402 \quad 1283
\end{aligned}
\]

**Changed to setting 500/550/1000**

\[
\begin{aligned}
& \text{0 P 66.9} \\
& \text{P = 355/144} \\
T & 500 & 6.5 & 19.5 & 127 \\
C & 550 & 4.2 & 31.4 & 132 \quad 769 \text{ W} \\
B & 1000 & 13.3 & 41.5 & 510 \\
\end{aligned}
\]

\[
\begin{aligned}
& 1212 \quad 1406 \quad 1498 \quad 1499 \quad 1502 \quad 1507 \quad 1512 \quad 1501 \quad 1443 \quad 1318 \\
& \text{should be OK at } \sim 475/550/1000
\end{aligned}
\]

\[
\begin{aligned}
T & 475 & 6.1 & 18.4 & 112 \quad 757 \text{ W} \quad 0.62 \text{ W/K} \\
C & 550 & 4.25 & 31.5 & 134 \\
B & 1000 & 12.3 & 41.5 & 510 \\
\end{aligned}
\]

\[
\begin{aligned}
& 1213 \quad 1413 \quad 1486 \quad 1498 \quad 1499 \quad 1500 \quad 1500 \quad 1483 \quad 1421 \quad 1292
\end{aligned}
\]

**Ramp down to 900K**

\[
\begin{aligned}
T & 500 & 7.2 & 14.0 & 101 \quad 507 \text{ W} \quad 0.79 \text{ W/K} \\
C & 0 & - & - \\
B & 1000 & 13.9 & 29.2 & 426 \\
\end{aligned}
\]

\[
\begin{aligned}
& 724 \quad 817 \quad 875 \quad 893 \quad 898 \quad 897 \quad 907 \quad 913 \quad 911 \quad 873 \quad 815
\end{aligned}
\]
421 motor amplifiers fitted
- need 412
Setting up the Internal LVDT's

Using RS dual channel card to drive 2 LVDT's

The sensitivity of the RDP transducers is ~63 mV/V/mm. For 5V excitation and 15mm travel, we have 948 mV/V output.

If we select 500 mV/V sensitivity, we should get \( \frac{948}{500} \times 5V \) output = 9.45 V per transducer. When two transducers are connected in series, we get 18.9 V — too much. The RS card can go linear up to 10V output. So if we put the excitations in series, i.e., 5V rms each, we get back to 9.45 V output.

The current outputs are \( \pm 10 \text{mA} \) or \( \pm 20 \text{mA} \). 20 mA would have to be split off-chip to give \( \pm 5 \text{mA} \) or \( \pm 10 \text{mA} \). But the current meter will only accept \( \pm 20 \text{mA} \).

So settle on voltage input to Eurotherm with excitations and signals in series.

Not yet calibrated.

Tried setting up the motor but need 5V square wave source. Checking on hard limits on actuator — not working yet.
Send them 2408 (PU)
Min low range - 19.99
Need - 99.99

Same for display

Interference between drive voltage and LVDT reading
Configuring INT LOAD Meter/Controller

13/3/99

Config parameters, p 6-7 in HbiK — not as ticked in the manual.

<table>
<thead>
<tr>
<th>Resistor used in 3B186</th>
<th>470 Ω</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal load</td>
<td>160 Ω</td>
</tr>
<tr>
<td>Internal torque</td>
<td>470 Ω</td>
</tr>
<tr>
<td>Internal &quot;</td>
<td>270 Ω</td>
</tr>
</tbody>
</table>

Set A11 as high alarm and A1.2 as low alarm.

Configured EXT LOAD Meter the same.

Somehow, axial motor now out of control.

15/3/99

Found that by reversing tacho polarity motor now runs OK — although there seems no reason for change of polarity; nothing was touched.

Decided not to ship as planned and to revise actuator panel layouts.

16/3/99
Task:
- Tune amplifier for motor
- Calibrate POS, ILC, ELC
- Adjust limit switches on actuator

To send:
- AD book
- RS Card details

**EXT F alarm does not stop motor**

Potassium ELC was 1.9503 mV/V, µm 20,000 µm

Beryllium ELC: 2.9573 mV/V, µm 30,000 µm

*Fluorite 67 meter*

| AB  | 264.4 |
| BD  | 263.9 |
| AC  | 263.9 |
| CD  | 263.4 |

1.0019  LOAD
1.0019  CELL
OK
Axial System

Axial actuator & ELC was attached, with spring in machine.
Connected spring with load cell (reading in first JHC blanked).
Heated up to OK.

Spring constant is -3.8 mm per 100 KN, or 1 mm = 263 KN
Running on MAN & POS controller:

<table>
<thead>
<tr>
<th>POS</th>
<th>1F</th>
<th>EF</th>
<th>SPEED</th>
<th>DEMAND</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.440</td>
<td>-62.8</td>
<td>-92.9</td>
<td>22</td>
<td>1.0</td>
</tr>
<tr>
<td>14.570</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>0.580</td>
<td>3.9</td>
<td>-63.2</td>
<td>2.6</td>
<td>5.6</td>
</tr>
<tr>
<td>0.650</td>
<td>-64.0</td>
<td>-94.4</td>
<td>-97.2</td>
<td></td>
</tr>
<tr>
<td>0.670</td>
<td>-64.4</td>
<td>-97.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.750</td>
<td>-65.0</td>
<td>&quot;</td>
<td>&quot;</td>
<td></td>
</tr>
<tr>
<td>0.800</td>
<td>-65.6</td>
<td>&quot;</td>
<td>&quot;</td>
<td></td>
</tr>
<tr>
<td>0.850</td>
<td>-66.2</td>
<td>&quot;</td>
<td>&quot;</td>
<td></td>
</tr>
</tbody>
</table>

Eng force zero is ~ -93.

Excitation on ELC = 10-14 V.
ELC zero is >100 KN off scale.

ELC resistances:

<table>
<thead>
<tr>
<th>Measurement</th>
<th>AB</th>
<th>BD</th>
<th>AC</th>
<th>CD</th>
<th>AD</th>
<th>BC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absolute</td>
<td>263.7</td>
<td>263.9</td>
<td>263.5</td>
<td>263.4</td>
<td>263.9</td>
<td>351.0</td>
</tr>
<tr>
<td>Re-measured</td>
<td>263.9</td>
<td>263.8</td>
<td>263.9</td>
<td>263.9</td>
<td>351.0</td>
<td>351.0</td>
</tr>
</tbody>
</table>

Note: Load cell seems out of balance.
For Pseudan TQ30W motor noise
9/3/99

Changed jumpers on 38/18's to Bipolar - now ELC & ILC can both be zero'd with ±100 KN range.

Check resistance on torque bridge - may need trimming a bit.
Amplifier connections:

For ground-active disable, set S1 ON.

To be sorted out.
Checking Torsion Control System

At first, couldn't get motor to run. Turned out that "off" pressure limits wiring had been connected to axial system. Motor ran when proper limits cable connected.

Turned motor:
- 5 Vdc - 5kHz square wave into remote.
- Function generator not working.

Got new function generator.
Still not much sense. Paul wanted to do his own thing.
5/6/99
Paul still adjusting. Turned out that he had function generator incorrectly connected into remote terminals yesterday.

Argument about which is on & off for switch 2. Paul insisted on his way which I think is incorrect.
7/6/99
I spent off with P. in Brokenhead & came back in afternoon.

The speed changes on torsion motor is locking in between 1:1 and 100:1, so presumably the 10 gap between the two ratios is not available - seems to miss by a few tenths mm at most.

Took motor out & checked dimensions. Body seems to be 3mm less than drawing. But the floating gear is not. So need to make a floating gear 3mm shorter. Also need a new gear change stem with the holes at 90°.

Reassembled without actuator, to use until a new gear is ready to install - which I can do in late August.
**Configuration of ELC meter**

<table>
<thead>
<tr>
<th>Function</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1 A</td>
<td>-100.0</td>
</tr>
<tr>
<td>A1 hi</td>
<td>OFF</td>
</tr>
<tr>
<td>A2 lo</td>
<td>OFF</td>
</tr>
<tr>
<td>A2 hi</td>
<td>+100.0</td>
</tr>
<tr>
<td>A1 ly</td>
<td>0.1</td>
</tr>
<tr>
<td>A2 ly</td>
<td>0.1</td>
</tr>
<tr>
<td>A1 te</td>
<td>0</td>
</tr>
<tr>
<td>A2 te</td>
<td>0</td>
</tr>
<tr>
<td>A1 rt</td>
<td>0</td>
</tr>
<tr>
<td>A2 rt</td>
<td>0</td>
</tr>
<tr>
<td>A1 no</td>
<td></td>
</tr>
<tr>
<td>A2 no</td>
<td></td>
</tr>
<tr>
<td>A2 sp</td>
<td></td>
</tr>
</tbody>
</table>

Resistance = 570 Ohm - too high 470 Ohm

Transducer Techniques wiring is for tension positive. For compression positive, we need to reverse the signal connections, i.e.:

- C GRN = signal
- B WHT = + signal.
Calibrating ELS

Transducer Technique Calib. \(2.9593 \text{ mV/V for } 30,000 \text{ lbs.}\)

Excitation 10.17 V

\[ 30 \cdot 0961 \text{ mV per } 30,000 \text{ lbs} \]

\[ 2.2046 \text{ lb/} \text{kg} \]
\[ 9.81 \text{ m/s}^2 \]

\( \approx 13,608 \text{ kg} \)
\( \approx 138,494 \text{ N} \)

\( \approx 22.545 \text{ mV per } 100,000 \text{ N} \)

Input 0 mV — net V output to 0.0 mV output.
and set CAL 1 to read zero.

Input -22.545 mV —
Axial Motor

Trying to tune motor.
Even with a small input, motor runs at max speed.
Tacho output 16.79 V (at 5.3 V in 1000 rpm = 3168 rpm)
readings 487 on speed meter.

With zero demand, speed builds up very slowly. Suggest tacho reversed, although sluggishness may be effect of not more magnetism.

Reversed tacho leads to same effect.
So motor/amplifier don’t seem to be operating in feedback mode.

Tried torsion motor with zero input. Ran OK after reversing the tacho. Act up PI roughly. Adjusted tacho gain to give 1962 speed for 75% demand.

1308  652  260  78  25  7  1.2
1308  50  25  10  3  1  0.3  0.1 \rightarrow 1rpm per 5.2s = 0.192 \text{mV} = 315 \text{rpm}.

So why is axial motor not controlling.
But input is OK.
Tacho feedback is OK. Couldn’t have been. Wiping open.

Replaced. Checked pore fluid motor. It seemed to control OK.
Put pore fluid amplifier into axial system.

Tried tacho two ways around; motor tends to build up revs, stuck and again.

8/6/99
Conclusion: previous problems due to a "dry joint" in the tacho feedback line.

Tacho: 5.3V per 1500 rpm
      15.9V per 3000 rpm

11½ rev in 5 min on 0.1
29.5 in 5 min
23 rev/min
Still working on axial motor tuning

1. Checking that we get a signal at the tacho terminal when square wave voltage is applied to REF ②③. Paul did some repair to winding wiring.

2. When monitoring voltage ④⑦, there was a problem of the voltage being sometimes 6V, sometimes 40 mA. This was independent of demand voltage. The 6V mode was associated with a high freq. noise that I had difficulty hearing.

3. Now abandoned the use of the 5-15V oscillator and used the two emitters, +13 on up to ±10 or more. Set the loop gain by going up until speed amplitude increased & back off a bit. Then put integrator in (constant) & I wound up the integral frequency a bit. The TMD switching +100 kohm and — a few percent overshoot.

\[
\begin{array}{|c|c|}
\hline
\text{Demand} & \text{Speed} \\
\hline
5 & 15 \\
10 & 30 \\
20 & 60 \\
30 & 90 \\
40 & 120 \\
\hline
\end{array}
\]

Adjusted tacho gain so that

\[
\begin{array}{|c|c|c|c|c|}
\hline
\text{Demand} & \text{5-Tach voltage} & 16.78/100^{-50} & 7.90 \\
\hline
20 & 3.35 & 15.97 & 15.84 \\
30 & 4.79 & 15.90 & 15.82 \\
40 & 6.36 & 15.90 & 0.056 \\
50 & 7.95 & 15.90 & 1.807 \\
60 & 9.53 & 15.88 & 1.023 \\
70 & 11.12 & 15.89 & 0.56 \\
80 & 12.70 & 15.88 & 0.40 \\
90 & 14.30 & 15.89 & 0.28 \\
100 & 15.87 & 0.2 & 0.26 \\
90 & 14.30 & 0.1 \\
20 & 3.35 & \\
\hline
\end{array}
\]

\[\text{Error in 25 sec}\]
Amplifier limit over-ride has to be wired in axial.

Alarms in Smokemmers:
- AL 1 - low limit
- AL 2 - high limit

Alarms are NO - check in wiring at back.

Bottom position 28, 58 -18
Top position 28

Bottom range of piston -15
Scale on actuator reads 20 when POS meter reads 15.8

Rum actuator to stop; triggered out at 28 mm by hitting
the pressure vessel; hard limit not tripped.

Set hard limit at bottom of actuator travel to trip out
just before actuator bottoms; scale reads ~18.4

Rum up to zero on scale & tightened nut

Rum down to contact of comp. piston; scale reading
in ~1.5.

Setting up AXIAL POSITION meter.

At present reading 15.59 in scale POS 1.0.

Scale POS. Eumeter

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>15.59</td>
</tr>
<tr>
<td>1.0</td>
<td>15.60</td>
</tr>
<tr>
<td>2</td>
<td>15.61</td>
</tr>
<tr>
<td>3</td>
<td>15.62</td>
</tr>
<tr>
<td>4</td>
<td>15.63</td>
</tr>
<tr>
<td>5</td>
<td>15.645</td>
</tr>
<tr>
<td>6</td>
<td>15.65</td>
</tr>
<tr>
<td>7</td>
<td>15.665</td>
</tr>
<tr>
<td>8</td>
<td>15.675</td>
</tr>
<tr>
<td>9</td>
<td>15.685</td>
</tr>
<tr>
<td>10</td>
<td>15.697</td>
</tr>
</tbody>
</table>

Contacting spring at M13.5

Scale (15.414 Eum.)

RS 646 - 583 set-up.

Frequency 5 kHz

Demand input impedance 100 kΩ

Corrected Eumeter: it is set for ±10 V input, 300 output, ±3
decimal points.

At POS Eumeter

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>13.5</td>
<td>15.413</td>
</tr>
<tr>
<td>12.0</td>
<td>15.410</td>
</tr>
<tr>
<td>11</td>
<td>15.409</td>
</tr>
<tr>
<td>10</td>
<td>15.408</td>
</tr>
<tr>
<td>9</td>
<td>15.405</td>
</tr>
<tr>
<td>8</td>
<td>15.405</td>
</tr>
</tbody>
</table>
The rate reading is 4.66, and there should be no difference.

Yesterday was 12...
Re-organized wiring on internal LVDT.

<table>
<thead>
<tr>
<th>POS</th>
<th>Sensitivity</th>
<th>Voltmeter (output)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.5</td>
<td>15.111</td>
<td>0.08</td>
</tr>
<tr>
<td>9.0</td>
<td>15.053</td>
<td>0.28</td>
</tr>
<tr>
<td>10.0</td>
<td>14.925</td>
<td>1.89</td>
</tr>
<tr>
<td>11.0</td>
<td>14.756</td>
<td>1.40</td>
</tr>
<tr>
<td>12.0</td>
<td>14.616</td>
<td>0.256</td>
</tr>
</tbody>
</table>

\[
\text{Voltage per \text{mm}} = \frac{0.146}{0.066} = 2.207 \\
\text{Voltage per \text{mm}} = \frac{0.256}{0.066} = 3.908
\]

Changed impedance jumper from 100 kΩ to 10 kΩ.

<table>
<thead>
<tr>
<th>POS</th>
<th>Sensitivity</th>
<th>Voltmeter (output)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.0</td>
<td>15.337</td>
<td>0.011</td>
</tr>
<tr>
<td>11.0</td>
<td>15.348</td>
<td>0.010</td>
</tr>
<tr>
<td>10.0</td>
<td>15.358</td>
<td>0.012</td>
</tr>
<tr>
<td>9.0</td>
<td>15.370</td>
<td>0.012</td>
</tr>
</tbody>
</table>

Changed jumper back to 100 kΩ.

Excitation checked at end of cable to transducer: 5.24 V.

Signal from transducer < 120 mV approx.

Attached the Fluke meter to signal at the lens connector below the load cell. Recorded disconnect.

<table>
<thead>
<tr>
<th>POS</th>
<th>Sensitivity</th>
<th>Fluke meter</th>
<th>Δ</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.0</td>
<td>106 mV</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>9.0</td>
<td>191 mV</td>
<td>76</td>
<td></td>
</tr>
<tr>
<td>10.0</td>
<td>267 mV</td>
<td>69</td>
<td></td>
</tr>
<tr>
<td>11.0</td>
<td>366 mV</td>
<td>86</td>
<td></td>
</tr>
<tr>
<td>12.0</td>
<td>452 mV</td>
<td>87 mV per mm, or 1.30 V per 15 mm.</td>
<td></td>
</tr>
</tbody>
</table>

Calib of LVDT: \( \frac{62 \text{ mV}}{5 \text{ V/mm}} = \frac{32.5 \text{ mV}}{1 \text{ V/mm}} \times 2 \times 2 \times 2 \) = 4.87 V per 15 mm.

Transducer calib gives 332 mV/mm, ie we should have 663 mV per mm out of two transducers.
<table>
<thead>
<tr>
<th>POS</th>
<th>hectic voltmeter</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>581</td>
<td>15</td>
<td>783</td>
<td>16</td>
</tr>
<tr>
<td>1</td>
<td>513</td>
<td>14</td>
<td>645</td>
<td>17</td>
</tr>
<tr>
<td>2</td>
<td>439</td>
<td>13</td>
<td>555</td>
<td>18</td>
</tr>
<tr>
<td>3</td>
<td>346</td>
<td>12</td>
<td>470</td>
<td>19</td>
</tr>
<tr>
<td>4</td>
<td>285</td>
<td>11</td>
<td>378</td>
<td>20</td>
</tr>
<tr>
<td>5</td>
<td>204</td>
<td>10</td>
<td>275</td>
<td>21</td>
</tr>
<tr>
<td>6</td>
<td>099</td>
<td>9</td>
<td>190</td>
<td>22</td>
</tr>
<tr>
<td>7</td>
<td>053</td>
<td>8</td>
<td>110</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td></td>
<td>24</td>
<td>1.662</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>26</td>
<td>1.862</td>
<td>27</td>
</tr>
</tbody>
</table>

Then full range measurements by Paul &Zone on HS card output vs position (from scale). The gave approx linear plot with
16.14 (for 1051) ie 2.68 earth units per 26 mm
13.46 (for 27) ie 0.103 earth units per 26 mm.
(Also 3.583 V for 26)
- 0.043 V per 19 mm
3.626
7

Earth unit is ± 10 V after ± 15 mm units
ie 10.667 V per unit
least volts output = 0.0023 V for 0.103 units
ie 0.022 V per unit = something incorrect

Connected Keithley voltmeter on DC to recorder output.

<table>
<thead>
<tr>
<th>POS</th>
<th>Keithley V</th>
<th>earth units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-0.1026</td>
<td>14.846</td>
</tr>
<tr>
<td>5</td>
<td>-0.2120</td>
<td>15.318</td>
</tr>
<tr>
<td>10</td>
<td>-0.674</td>
<td>16.011</td>
</tr>
<tr>
<td>15</td>
<td>-1.129</td>
<td>16.694</td>
</tr>
<tr>
<td>20</td>
<td>-1.584</td>
<td>17.376</td>
</tr>
<tr>
<td>25</td>
<td>-2.095</td>
<td>18.143</td>
</tr>
</tbody>
</table>

10 mm per 0.93 V
10 mm per 1.42 earth units
1 V = 157 earth units
2.1976 V per 24 mm
2.747 V per 30 mm. If we should have 20 V per 30 mm, i.e. 7.28 x as much
7.346 → 10
0.597 ←
25.810

Got stuck on ALARM 1 on POS — did not show on front face

Here to reverse polarity of V output, for axial POS.
We used 69 mV/V setting instead of 500 mV/V setting.

IE 50/150 mV range.

Eurometer reading now 29.182. Changed grounding pins to Z2 & Z3
& moved "B" to 15 POS to read 25.

<table>
<thead>
<tr>
<th>POS</th>
<th>Euro  Volts</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>24.995  -6.662</td>
</tr>
<tr>
<td>20</td>
<td>21.370  -4.246</td>
</tr>
<tr>
<td>15</td>
<td>17.653  -1.769</td>
</tr>
</tbody>
</table>

Reset Euro reading to 15.60 using Z (end of adjustment)

<table>
<thead>
<tr>
<th>POS</th>
<th>Euro  Volts</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>15.597  -0.398</td>
</tr>
<tr>
<td>20</td>
<td>19.247  -2.831</td>
</tr>
<tr>
<td>25</td>
<td>22.965  -5.309</td>
</tr>
</tbody>
</table>

Increased S:

<table>
<thead>
<tr>
<th>POS</th>
<th>Euro  Volts</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>25.825  -7.215</td>
</tr>
<tr>
<td>20</td>
<td>20.722  -3.813</td>
</tr>
<tr>
<td>15</td>
<td>15.831  -0.553</td>
</tr>
</tbody>
</table>

Changed Z without pins Z1 & Z3, grounded to 15 reading at 15.

<table>
<thead>
<tr>
<th>POS</th>
<th>Euro  Volts</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>14.998  0.002</td>
</tr>
<tr>
<td>20</td>
<td>19.87   -3.247</td>
</tr>
<tr>
<td>25</td>
<td>24.979  -6.052</td>
</tr>
</tbody>
</table>

Good enough against the scale reading. Now need to calibrate against disk gauge.

But I still don't understand why we have to use so much gain?? and why the LVDT outputs minimum at POS 7.

Left at 24.976  -6.649
$$\text{Output} = 10 \cdot \frac{350}{350 + R} - 5 = 0.00914\, \text{V for LLC}$$

$$\frac{350}{350 + R} = 0.5 - 0.00914$$

$$R = 1.282\, \Omega$$

$$\frac{1}{350 + \Delta R} = \frac{1}{350} + \frac{1}{\Delta R}$$

$$\Delta R = 9579\, \Omega$$

For LLC, 2Ω is of by smaller amount. Similar calculation gives $\Delta R = 32Ω$, and so trimming resistor:

Now in LLC

[Handwritten notes:]

For ITC, 2Ω is off by smaller amount. Similar calculation gives $\Delta R = 32Ω$, and so trimming resistor:

Now in ITC

[Handwritten notes:]

getting worse
Paul tied up 14VDT axial connector.

Looked at offsets of 16C & 17C. Set the zner's halfway on 3B18 & measured mV signal below 3B18 box. Calculated correction resistors as opposite & fitted them between terminals bottom & second bottom 0.1% 190K for 16C & 530K for 17C.

Set dial gauge to about 180.00

<table>
<thead>
<tr>
<th>POS</th>
<th>Dialgage</th>
</tr>
</thead>
<tbody>
<tr>
<td>26.976</td>
<td>19.150</td>
</tr>
<tr>
<td>25.996</td>
<td>18.035</td>
</tr>
<tr>
<td>20.052</td>
<td>12.110</td>
</tr>
<tr>
<td>15.045</td>
<td>7.005</td>
</tr>
<tr>
<td>10.047</td>
<td>1.745</td>
</tr>
<tr>
<td>14.986</td>
<td>6.928</td>
</tr>
<tr>
<td>19.977</td>
<td>12.020</td>
</tr>
<tr>
<td>15.004</td>
<td>6.994</td>
</tr>
</tbody>
</table>

went to 9.980

Problem with axial actuator occasionally not coming on when switched on — goes into fault, as if alarm trips, but not an alarm. Can clear the problem by down—powering & then powering up again.

$\Delta = 10.028$

need to reduce to 24.984

| 24.984 | 0.072 |
| 0.071 | after a minute or so |

4.898 | 20.083 |

9.975 | 15.006 |

14.572 | 10.009 |

19.991 | 5.403 |

changed

5.081 | 19.744 |

9.987 | 14.460 |

15.028 | 10.000 |

19.976 | 5.315 |

24.986 | 0.402 |
Lifted #1 cable line on motor amp.
<table>
<thead>
<tr>
<th>Euro.</th>
<th>DG</th>
</tr>
</thead>
<tbody>
<tr>
<td>25.050</td>
<td>0.278</td>
</tr>
<tr>
<td>20.013</td>
<td>5.032</td>
</tr>
<tr>
<td>15.007</td>
<td>9.670</td>
</tr>
<tr>
<td>10.022</td>
<td>14.172</td>
</tr>
<tr>
<td></td>
<td>ran out of contact</td>
</tr>
<tr>
<td></td>
<td>5.11 19.74</td>
</tr>
<tr>
<td></td>
<td>6.255 0.150 red readings now</td>
</tr>
<tr>
<td>10.016</td>
<td>5.805</td>
</tr>
<tr>
<td>14.995</td>
<td>10.318</td>
</tr>
<tr>
<td>20.002</td>
<td>14.955</td>
</tr>
<tr>
<td>24.998</td>
<td>19.748</td>
</tr>
</tbody>
</table>

Turned around at 25.052 Euro.

<table>
<thead>
<tr>
<th>Euro.</th>
<th>DG</th>
</tr>
</thead>
<tbody>
<tr>
<td>25.052</td>
<td>14.870 red numbers</td>
</tr>
<tr>
<td>24.012</td>
<td>16.725</td>
</tr>
<tr>
<td>22.011</td>
<td>28.858</td>
</tr>
<tr>
<td>20.007</td>
<td>4.942</td>
</tr>
<tr>
<td>18.008</td>
<td>7.060</td>
</tr>
<tr>
<td>16.006</td>
<td>9.218</td>
</tr>
<tr>
<td>14.007</td>
<td>11.378</td>
</tr>
<tr>
<td>12.016</td>
<td>13.558</td>
</tr>
<tr>
<td>10.013</td>
<td>15.808</td>
</tr>
<tr>
<td>8.015</td>
<td>18.105</td>
</tr>
<tr>
<td>~ 6.2</td>
<td>20.255</td>
</tr>
</tbody>
</table>

The plot looks like:

Why?

Try changing span:

15.99

<table>
<thead>
<tr>
<th>Euro.</th>
<th>DG</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.606</td>
<td>0.000</td>
</tr>
<tr>
<td>6.069</td>
<td>0.520</td>
</tr>
<tr>
<td>8.048</td>
<td>2.706</td>
</tr>
<tr>
<td>10.003</td>
<td>4.854</td>
</tr>
<tr>
<td>11.981</td>
<td>6.976</td>
</tr>
<tr>
<td>14.076</td>
<td>9.170</td>
</tr>
<tr>
<td>15.990</td>
<td>11.148</td>
</tr>
<tr>
<td>18.005</td>
<td>13.218</td>
</tr>
<tr>
<td>POS</td>
<td>1E</td>
</tr>
<tr>
<td>-----</td>
<td>----</td>
</tr>
<tr>
<td>D.S.</td>
<td>5.280</td>
</tr>
<tr>
<td>ELC</td>
<td>0.9</td>
</tr>
<tr>
<td>P.S.</td>
<td>5.878</td>
</tr>
<tr>
<td>5073</td>
<td>364</td>
</tr>
<tr>
<td>5.562</td>
<td>5.562</td>
</tr>
<tr>
<td>5.642</td>
<td>5.642</td>
</tr>
</tbody>
</table>

**Note:** The table values are rounded and may not sum up exactly due to rounding differences.
LC ranging resistor 1652

Overnight Paul changed polarity of wire signal leads out of LC to get it reading in correct sign.

Check buffer under VRD7 carrier?

Reduce thickness of venting blocks, or make a spacer for spring.

Oil level connection too sluggish.
Testing 1LC

Started with POS 1LC Volts EL24 CP
12.6v 4 1.46 0.280 0.6 18.14

Left overnight last night at bottle pressure after flushing.
Pumped up to 121.14 Pa.

15.435 -15.08 -1.373 1.0

Why has this gone up? The LVDT seems to be pretty sensitive -- due to heating? or a bit of rubber trapped under LVDT carrier?

After Paul changed polarity of signal leads, he did not change one the balancing resistor. When he did change the resistor, the wedge went so out of balance that the gain adjust on the 3B18 (I) could only bring the 1LC back to read 96.11 at 30 Pa. So check now:

CP POS 1LC(two) 1LC Volts EL24
30 13.250 96.11 11.919 0.8

Gain adjuster

30 14.474 96.11 11.919 3.4

No response from 1LC; backed off.

30 13.886 96.11 11.919 0.9

Changed back to 41052 resistor that was in 3B18 before. Now

30 14.886 57.66 8.07 -0.9
14.886 57.22 5.03 0.1

Took out & used another ranging card (fault in one with the 1652 ? ?) with 1652 gain resistor.

95.95 1.2 upwards

Contact 95.95

No 1LC signal for 41 kN external load. What is happening?

Changed balancing resistor back between bottom & third from bottom terminals under 3B18.

Now get about 1 kN of 1LC in 2.8 kN of EL24 but wrong sign!!

There has evidently been quite a bit of confusion about leads.

Swapped over the leads on the 1LC side of the Line connector to change polarity. Error? still goes even though the balancing
IL VDT is pressure sensitive & creeping
<table>
<thead>
<tr>
<th>Time</th>
<th>R05</th>
<th>LLEuro</th>
<th>LCVth</th>
<th>LLEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.94</td>
<td>-0.02</td>
<td>0.016</td>
<td>-0.09</td>
<td></td>
</tr>
<tr>
<td>14.10</td>
<td>-0.01</td>
<td>0.016</td>
<td>0.7 (1.2 in motion)</td>
<td></td>
</tr>
<tr>
<td>14.56</td>
<td>-1.07</td>
<td>-0.090</td>
<td>4.2</td>
<td>ITC</td>
</tr>
<tr>
<td>14.238</td>
<td>-0.01</td>
<td>-1.1</td>
<td>1.1</td>
<td>-1.79</td>
</tr>
<tr>
<td>14.530</td>
<td>-1.01</td>
<td>-0.083</td>
<td>4.0</td>
<td>-2.39</td>
</tr>
<tr>
<td>14.211</td>
<td>-0.01</td>
<td>0.017</td>
<td>1.1</td>
<td>-1.79</td>
</tr>
</tbody>
</table>

Found that LLEC was connected to the ITC measuring channel & vice versa.

<table>
<thead>
<tr>
<th>Time</th>
<th>R05</th>
<th>LLEuro</th>
<th>LCVth</th>
<th>LLEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.363</td>
<td>-0.01</td>
<td>0.000</td>
<td>0.9</td>
<td>-0.88</td>
</tr>
<tr>
<td>14.56</td>
<td>1.90</td>
<td>0.192</td>
<td>6.7</td>
<td>-0.88</td>
</tr>
</tbody>
</table>

Changed polarity of LLE signal out of LLEC again.

Now white on 4 and red on 2

Centre of zero range is -31 on Euro, 2.3mV.

Changed over the balance resistors so that LLEC & ITC both zero OK.

LLEC balancing resistor = 330kΩ
ITC balancing resistor = 100kΩ.

<table>
<thead>
<tr>
<th>Time</th>
<th>R05</th>
<th>LLEuro</th>
<th>LCVth</th>
<th>LLEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.363</td>
<td>-0.01</td>
<td>0.000</td>
<td>0.9</td>
<td>-0.88</td>
</tr>
</tbody>
</table>

Pumping up.

<table>
<thead>
<tr>
<th>Time</th>
<th>R05</th>
<th>LLEuro</th>
<th>LCVth</th>
<th>LLEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.374</td>
<td>8.31</td>
<td>0.332</td>
<td>1.4</td>
<td>5.27</td>
</tr>
<tr>
<td>14.410</td>
<td>3.31</td>
<td>0.432</td>
<td>1.41</td>
<td>-5.25</td>
</tr>
</tbody>
</table>

LVDT is creeping up in value so the LVDT body is moving up, ie away from the fixed point.
<table>
<thead>
<tr>
<th>Channel 1</th>
<th>POS</th>
<th>-2V to +2V</th>
<th>Min 12 - 18mm</th>
<th>6mm F/S</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>LC</td>
<td>0 to 75V</td>
<td>0 to 150°</td>
<td>50 kN</td>
</tr>
<tr>
<td>2</td>
<td>ELC</td>
<td>-1 to +4V</td>
<td>-10 to +40°</td>
<td>50 kN</td>
</tr>
<tr>
<td>3</td>
<td>CP</td>
<td>0 to ±14V</td>
<td>0 - 500 kHz</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>EPOS</td>
<td>2.4 to 5.2</td>
<td>for 12 - 18 POS</td>
<td>6mm F/S</td>
</tr>
</tbody>
</table>

Set bleed valve

Reduce head of screw

Check groove finish in bottom plug (O.D. & pistons)

Reason of pressure leak (due to glass transition?)
<table>
<thead>
<tr>
<th>EP</th>
<th>POS</th>
<th>1LCm</th>
<th>1LC-V</th>
<th>ELC</th>
<th>ITC</th>
</tr>
</thead>
<tbody>
<tr>
<td>118</td>
<td>14:40</td>
<td>3:28</td>
<td>0:329</td>
<td>-1:5</td>
<td>-5:23</td>
</tr>
<tr>
<td></td>
<td>0.5</td>
<td>1.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14:944</td>
<td>5.08</td>
<td>0-570</td>
<td>7.1</td>
<td>-6.07</td>
<td></td>
</tr>
<tr>
<td>again</td>
<td>14:775</td>
<td>3.70</td>
<td>0.371</td>
<td>2.4</td>
<td>-5.32</td>
</tr>
<tr>
<td>14:906</td>
<td>4.93</td>
<td>0.495</td>
<td>5.5</td>
<td>-5.83</td>
<td></td>
</tr>
<tr>
<td>15:033</td>
<td>5.34</td>
<td>0.586</td>
<td>9.0</td>
<td>-6.60</td>
<td></td>
</tr>
</tbody>
</table>

0.258

*Changed gain resistor 165 to 3952.*

*Can only zero to 1153 kN.*

*Run on chart recorder.*

*Initial slope of IF is greater now than EF.*

\[ \text{EF} \]

\[ \text{IF} \]

\[ \text{POS} \]

<table>
<thead>
<tr>
<th>EP</th>
<th>POS</th>
<th>1LCm</th>
<th>1LC-V</th>
<th>ELC</th>
<th>ITC</th>
</tr>
</thead>
<tbody>
<tr>
<td>118</td>
<td>14:260</td>
<td>11:58</td>
<td>2:967</td>
<td>-1:8</td>
<td>5:23</td>
</tr>
<tr>
<td>300</td>
<td>14:259</td>
<td>11:14</td>
<td>2:923</td>
<td>1:8</td>
<td>-10:13</td>
</tr>
</tbody>
</table>

*Run again at 200 MPa on chart recorder. Same relationship of F to POS for both EF & IF, so load cell response is same at 200 MPa as at 118 MPa, and is grossly non-linear in both cases.*

*Probably not enough clearance between the two elements of the vent/TC connector.*

**Pumped up to 400 MPa, sudden heavy leak, dropped pressure rapidly, leak stopped at about 240 MPa, holding well.**

<table>
<thead>
<tr>
<th>Relaxed pressure</th>
<th>239</th>
<th>14:712</th>
<th>15:48</th>
<th>3:358</th>
<th>0.3</th>
<th>-8:98</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>14:38</td>
<td>-19</td>
<td>0</td>
<td>1:0</td>
<td>1:11 immediately</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>14:382</td>
<td>-17:4</td>
<td>0.065</td>
<td>1:1</td>
<td>1:10 1min</td>
<td></td>
</tr>
<tr>
<td>14:455</td>
<td>-22:15</td>
<td>-0.406</td>
<td>0.3</td>
<td>1:09</td>
<td>2min</td>
<td></td>
</tr>
<tr>
<td>14:467</td>
<td>-21:60</td>
<td>-0.357</td>
<td>0-2</td>
<td>1:06</td>
<td>5min top plug out</td>
<td></td>
</tr>
</tbody>
</table>
In future, make bottom end of cal rods for torsion the same as bottom end of spc. assembly in order to seal venting assembly

External LVDT not registering on recorder
Take out gapping & put in torsion cal rod & block.

Problem: that there is no scaling cover for the venting block.

Need:

Also temporarily we need

both out of 4'40.
Paul changed our polarity of R N D T input. now small new flashing

-0.14S (same as last time, on other controllers)

 Came good again when re-connected up. Paul thinks there was a
spike from the soldering iron, due to smoking to disconnect
while soldering.

To be done:

 Axial: cal speed, cal TF (neg miniing), limits override etc. . . 1½ days
 Torsion: cal POS, IT, ET, speed, check limits (rod ratio ??) . . 1½ "
 Pos fluid: motor, cal t, limits
 LVDT load cell

 Calib & check furnaces (2) . .

Note:

 Tests

  a

  7 days.
  2½ .
  9½ days.
13/6/99

Problem with Eurotherm for Torque Positioning

Display was not blinking when first fired up in
Baynton (according to the recollection of me & Tony)
but after a few days (from Tues 1/6/99 to early in week of 6/6/99)
the display took to blinking with 0.140 value.

Controller set to 4-20mA input, 0-1400 display.
We tried setting remote input to the same (was 1) but no help.
If another controller is inserted, everything OK.
Conclusion — a fault in this controller.

Test in the control unit from por fluidics system #120.
Now reads steady.
Input 4-20mA
Display 0-1400

Double-checked Eurotherm controller & re-tuned display to 0-50
for por fluid PCS — now flashing -95.000, it resets 10% range.

Eurotherm not working
in #120
Axial speed calib.

At OP = 14.154, run upwards in good part of cal curve.
Put OP = 2.0, speed reading = 9

0 sec 60 sec
14.154 14.780 at speed 9 (OP = 2) in 60 sec
Thus at OP = 2,
14.780 - 14.154 = 0.626 mm per 60 sec
0.0104 mm/s
10.4 μm/s — reads 9

0 P = 30, 19.606 - 14.780 = 4.826 mm per 30 sec
0.1609 mm/s
or 160.9 μm/s — reads 139

0 P = -30, 20.575 - 15.804 = 4.771 mm/30 s
0.1590
or 159.0 μm/s — reads 139

Calibrated the meter using 2 point scaling method.

At OP = 100, speed ~ 485 gradually iner to 5751R
-100 - 450 "
514 μm/s = 0.0514 rps X 1000 gearing = 514 rps
= 3084 rpm — OK.

All this is on 1:1 reduction ratio.

Checked at 100:1 " " — OK.
Very difficult to assemble torque calrod.
Internal torque cell
Put in cal rod, steadied top end in top plug & pulled with spinner.
17 reading goes down with pulling in either sense. ?

**Problem with RVDT:**
- Paul thinks 3B17 is on block.
- Put in another 3B17
- Check excitation on RVDT - 3.68 V whereas it is 5 V on PP 3817.
- Output from Torion P85 is -14.17 V as measured on recorder output.
- Put in PP 3B17 and got a registration of recorder output of -8.8 to -9.0, monotonic.
- Put PP ranging card into blank 3B17 - no excitation.
- Put PP ranging card into blank 3B17 - no excitation.
- Both new 3B17’s from AE Collins seem to be dead.
- Contacted German agent for local replacement.

14/6/99
1. A POS
2. IF
3. EF
4. CP

Recorder settings as on p. 47 except:
5. IT 0 to 5 V 0 to +50 500 Nm

Broke ratchet wrench due to screws on top of actuator too tight

Screws on top of actuator too long - too difficult to get out. Also only 4 screws fitted.

EDC not enough clearance in yoke

No rod for the bottom plug extraction bar

Contact 27.58

No tool for undoing top of LLC 4403-4

No tool for undoing cap nut on bottom plug

Stem of LVDT carried in LLC bent - difficult to remove

Only one pin in bottom of SG LLC, between the elastic cylinders.

Top plug insertion tool goes on spring a fraction of a thread & on second turn none plug not at all

Bore of 10 ID tube for LLC leads is very rough & cut, heat shrink - it is also smaller at the ends then in the middle.
11C Calibration (cf p48)

We re-inserted the spring with a 1.6 thick ring.
Original TP was 13.3 (at 43 MPA was 13.8)
New TP was 12.18
1F reading at zero pressure = -20.59

<table>
<thead>
<tr>
<th>CP</th>
<th>POS</th>
<th>1F Eino</th>
<th>1F Vol (5)</th>
<th>EF</th>
<th>IT</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>11.917</td>
<td>-20.13</td>
<td>-0.3</td>
<td>1.11</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>11.981</td>
<td>-15.65</td>
<td>-3.1</td>
<td>2.20</td>
<td></td>
</tr>
</tbody>
</table>

There was extreme force ~ 6.9 oz, which was removed by running actuator up a bit

Still the same non linearity in 1F loading curve. There is very little free travel, if any.

Dismantled 11C

Bottom nut tight, so load it to 20 kN (contact 27.58)

Feed bottom nut until bottom plug stack. Tried hammering on an inverted furnace can then on a rod on the top of the 11C. Not budging.

Georg making up a screw loading arm for the top nut

Need to be able to push on the PLC to push out the bottom plug. Since 20 kN was enough to loosen it upwards, a similar load should make it possible to push it out.

Got the bottom plug out by using a bar fitted to the inner top nut. By loading through, a brace piece, a thread to pusher upside down & a brass cal rod; came out with considerable effort on the nut.

No obvious extrusion of seal-nut ring in correct place & O-ring in good condition came slight put on 1/2. However, later I could see slight extrusion on the inside ring (probably from the 700 kPa test).

The pressure on the plug was 400 MPA (p48)
Should always check mitering extension after 700-710 feet.

Note in manual about tightening comp piston on interconnect to LLC piston.

Bottom plug seal diameter oversized by 0.050
Re-assembled load cell, after careful trimming & greasing of threads & springs, and with blank in place of vent & cap blocks. Seemed to go together OK but did not put in Andy's piece for retaining wires in place. This could have been the problem with calib.

On putting bottom plug back in, it was very tight. Measured \( \frac{67.900}{67.040} \) for the bore spec. in 67.900/67.030

Blank plug goes in easily.

Tomorrow morning George will try taking off 0.030 by hand in lathe.
LT (Temp) close panel hole eccentric to closure hole, so knob does not work properly.

Have set all /1 off in our third steps.

No tool for feed-through retaining nuts.

Bottom plug fitting — see opp.

Open up vent hole from comp. region of bottom plug.

Note in manual on importance of tightening piston interconnect.
**Conclusions from 17/6/99**

After trying to start the motor, it could not get it to start—possibly, the system is still disabled. Turned off AH71 in stroke even but still disabled.

**Bottom plug**

George took off 0.030 from plug, still too tight.

- Another 0.020 + 0.030 removed plug now down to 0.020 or slightly under.

- Measured core pressure in main rotor
  - Compression: 145.000
  - Plug head of bottom plug: 144.970

New have 0.030 clearance on $\phi 67$ section of plug too. It just goes in, with a bit of a grinding feeling—may be the groovy finish on the $\phi 65$ of plug.

A few sharp edges cleaned off here & there.

**In fluid motor**

Lifted the interrupt line & set the loop gain + integrated freq. limit did not yet set to loop gain.

**Reinstalled LLC**

With vent block in place.

<table>
<thead>
<tr>
<th>CP</th>
<th>POS</th>
<th>IF</th>
<th>EF</th>
<th>IT</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>12.932</td>
<td>-5.56</td>
<td>0.9</td>
<td>160</td>
</tr>
<tr>
<td>40</td>
<td>13.063</td>
<td>0.41</td>
<td>1.1</td>
<td>-0.75</td>
</tr>
<tr>
<td>70</td>
<td>13.15</td>
<td>4.8</td>
<td>1.3</td>
<td>2.9</td>
</tr>
<tr>
<td>100</td>
<td>13.21</td>
<td>9.4</td>
<td>1.3</td>
<td>-4.6</td>
</tr>
<tr>
<td>109</td>
<td>13.15</td>
<td>8.87</td>
<td>1.6</td>
<td>-4.4</td>
</tr>
</tbody>
</table>

Repeated LLC cal test on spring—same now.

**Linearity as before.** Dropped it.

On initially testing at 100.71 Pa, there was a
Assemblies OK at POS 1.3
higher zero (4 div) then later + a bit of initial take-up. Later this was reproduced well.

The IF - AD curve was similar to but not exactly the same as previously. A higher load led to slight stiffening of the response. A large hysteresis

Tighten bolt well out.

When pushing down on anvil, the anvil seats nicely, spring loaded by venting coil.

When a washer is put on top of packing piece, anvil is firm above seating.

Washer in 2.7 mm, so a 2.2 mm washer would give just closing of vent assembly.

Re-assembled LC in bottom plug 2 into machine, with gasket under spring.

<table>
<thead>
<tr>
<th>Row</th>
<th>TP</th>
<th>CP</th>
<th>P05</th>
<th>IF</th>
<th>EF</th>
<th>IT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12.0</td>
<td>11.808</td>
<td>-20.50</td>
<td>0.3</td>
<td>1.71</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>11.87</td>
<td>-8.25</td>
<td>1.2</td>
<td>0.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>11.871</td>
<td>-7.95</td>
<td>0.78</td>
<td>drifting slowly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>180</td>
<td>12.02</td>
<td>7.1</td>
<td>18</td>
<td>3.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>109</td>
<td>12.082</td>
<td>10.52</td>
<td>1.8</td>
<td>-4.55 on reaching CP.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>107</td>
<td>12.120</td>
<td>10.20</td>
<td>-0.1</td>
<td>-4.47</td>
<td></td>
<td></td>
</tr>
<tr>
<td>106</td>
<td>12.147</td>
<td>10.09</td>
<td>-0.1</td>
<td>-4.46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>106</td>
<td>12.177</td>
<td>9.97</td>
<td>-0.1</td>
<td>-4.45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>106</td>
<td>12.190</td>
<td>9.93</td>
<td>-0.1</td>
<td>-4.44</td>
<td></td>
<td></td>
</tr>
<tr>
<td>106</td>
<td>12.199</td>
<td>9.91</td>
<td>-0.1</td>
<td>-4.44</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2nd shift in first cycle.


105 12.744 8.32 0.2 -4.42

Pumps up to 200 lb.

204 12.746 12.24 8.0 -8.27

203 12.754 12.34 0.0 -8.26 after changing EF
M3 screws for attaching furnaces can be used.
Various M3 screws for LVDT load cell
<table>
<thead>
<tr>
<th>CP</th>
<th>POS</th>
<th>IF</th>
<th>EF</th>
<th>IT</th>
</tr>
</thead>
<tbody>
<tr>
<td>203</td>
<td>12.774</td>
<td>12.50</td>
<td>-0.1</td>
<td>-8.28</td>
</tr>
<tr>
<td>206</td>
<td>12.780</td>
<td>12.54</td>
<td>-0.1</td>
<td>-8.29</td>
</tr>
</tbody>
</table>

Ran fast & slow cal cycles

Dropped CP back to 100

104 | 12.451 | 9.46 | -1.6 | -4.26 |
106 | 12.418 | 9.72 | -1.5 | -4.35 |
107 | 12.482 | 9.86 | -1.5 | -4.37 |

Ran slow, then fast cal
Back to zero pressure

|   | 11.458 | -21.11 | 0.4 | 1.74 |
|   | 11.448 | -20.99 | 0.4 | 1.75 |
|   | 11.355 | -20.43 | 0.5 | 1.79 |

Decided that the 56 load cell is kaput, probably due to strain gauges even though this seems unlikely.
Discussions on what to do about load cell etc. Must to send new G407 therm for repair (a new one ordered but it will be longer). 3B17 still not there yet.
Sent Paul home to rest – a bit stressed out – until Sunday.

For LVD load cell, had Georg:
1. Fit location pins on load cell plate
2. Polish inside load cell seat
3. Collecting screws for all parts

New furnace plug not fit extracting tool
Milling too tight in roof plug
Ensurance testing

Assembled furnace on pre-used plug, using prototype RCP furnace.

Tried to put in cal assembly but it got jammed in plug.

When went to take furnace out to extract piston, top nut got sticky. Got it out, cleaned it; some surface wire threads on the rough. Worked over the threads a bit & re-applied 103.

Problem with O-ring compressing cap eccentric to piston, and piston ring too tight.

O-juned these up — goes in better. Assembled.
Blank filler in 16C.

TP at 0102 = 15.5

Three tries to switch on furnace.

P 54.5 I 20.7 D 34.5

Reset P = 10, I = 200, D = 50

SP = 800

0 1 2 3 4 5 6 7 8 9 10

520 584 649 705 757 803 833 862 850 819

settings A B W

T 450 7.6 14 106

C 500 7.8 31.3 24.4

B 100 14.5 24.4 3.54 1.33 W/K

\[ \frac{704}{23} \]

Changed to SP = 900 K, & 500/6/1000 setings.

Stuck at ~ 803 K with OP = 100.

New temperature dropping.

Stopped run.

Next morning — condensation on wall of vessel, presumably due to furnace not being pre-baked. Wiped out.

One of connectors pulled out when pulling off furnace
LYDT is sensitive to both pressure

Note in MANUAL about clearing range before starting furnace

Why so much change when actuator has not been on?

Winding T/C readings are fluctuating by 2-3 K
Furnace No. 24

Inspected furnace 24, PS2-insulated.
POS 14.112, when left yesterday.
Used same gage assembly as yesterday. PS2 + AbO3 (piece from ASD).

Ramping up with furnace TC (no.1) on control, with
CP = 250 F/6K.

At ~ 570 K, OP ~ 54
At ~ 656 K, POS = 14.686
CP = 275 F/6K.

ID = 10/200/50 as yesterday.

If end of ramp (900) overshoot by 37 K.
OP cycling up to ~ 54 & down to 47
55
55.1
48
46.8

Did an A-T Run.

P = 3.8
I = 153
D = 25.5
4.8
16.5
27.5

Another CV Run

CP = 14.694

925 942 934 919 904 892 889 860 821 settings 500/1/1000
600/200/1000
923 942 934 921 907 896 884 865 829
1106 1141 1156 1159 1128 1140 1133 1082
812 845 857 858 853 857 856 844 812
802 803 805 805 804 802 794 771
756 755 753 750 746
742 748 747 745 742 738 728 704

CP 723 745 754 755 752 749 743
T 1000 82 17 96
400 16 6 268 0.56 W/K.

Ramping up to 1200 K on AUTO with

PID = 10, 200, 50

Overheat by 5 K.

1222 1222 1116 1205 1199 1200 1208 1210 1165
1211 1216 1206 100198 1195 1194 1180
1000/1000

Changed to conduct on TC 5 with

PID = 5, 80, 20

TC 5 = 830
\[ TC(5) = 830 \, K \]

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>( \frac{102}{99} )</td>
<td>( \frac{1000}{500} / 1000 )</td>
<td></td>
</tr>
<tr>
<td>1158</td>
<td>1203</td>
<td>1193</td>
<td>1184</td>
<td>1180</td>
<td>1177</td>
<td>1165</td>
<td>1112</td>
<td>( \frac{1000}{500} / 500 )</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1215</td>
<td>1218</td>
<td>1209</td>
<td>1207</td>
<td>1201</td>
<td>1203</td>
<td>1186</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1175</td>
<td>1235</td>
<td>1249</td>
<td>1247</td>
<td>1244</td>
<td>1242</td>
<td>1233</td>
<td>1156</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1190</td>
<td>1262</td>
<td>1287</td>
<td>1291</td>
<td>1292</td>
<td>1290</td>
<td>1286</td>
<td>1265</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ \begin{align*} 
T & \begin{array}{c|c|c|c|c|c} x & 1 & 2 & 3 & 4 & 5 \\ \hline w & 20 & 8.5 & 170 \\ y & 650 & 25 & 40 & 100 & 519 \\ z & 940 & 830 & 28 & 89 & 249 \end{array} \\
\end{align*} \]

\[ OP = 0.82 \, W/K \]

\[ 3.14 \, MPa \]

**Ramped up to \( TC(5) = 920 \, K \)**

\[ \begin{array}{c|c|c|c|c|c|c|c|c} x & 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 \\ \hline xx & 1303 & 1371 & 1382 & 1377 & 1373 & 1372 & 1372 & 1358 \\ y & 1298 & 1363 & 1370 & 1364 & 1361 & 1361 & 1364 & 1353 \\ z & 1301 & 1369 & 1382 & 1378 & 1375 & 1376 & 1379 & 1368 \\ w & 1305 & 1381 & 1397 & 1397 & 1396 & 1398 & 1403 & 1403 \\ x & 1303 & 1384 & 1404 & 1496 & 1437 & 1430 & 1413 & 1403 \\ \end{array} \]

\[ \begin{align*} 
T & \begin{array}{c|c|c|c|c|c} x & 1 & 2 & 3 & 4 & 5 \\ \hline w & 23 & 88 & 202 \\ y & 670 & 985 & 27 & 40 & 148 & 598 \\ z & 930 & 920 & 32 & 90 & 288 \end{array} \\
\end{align*} \]

\[ OP = 48 \pm 1 \, 319 \, MPa \]

**Ramped up to \( TC(5) = 1000 \, K \)**

**Increased \( \theta \) to 6**, so \( PID = 6.0 \, 8.0 \, 20 \)

*Furnace seemed to run out of control; saw 1700K on \( T/C \), quickly withdrew. Went over to manual at OP 52; setting back OP; still 1600+ at OP 48 at 1958.

Cut settings back to 800/700/1000 on OP 47.

Thermocouple no longer go into specimen, so abandoned run.*
20/6/99

Assembling LVDT Load Cell.

Installed the LVDT’s as at left & arranged their position in case of IF & IT to have excitation in-board (IF) or convenience for wiring IT.

Discussed wiring with Paul.

Cont’d p78
Exercise no. 24: Second run (cf. p. 70)

Put on MANUAL at \( OP = 43.0 \)

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td>815</td>
<td>841</td>
<td>849</td>
<td>849</td>
<td>848</td>
<td>847</td>
<td>844</td>
<td>835</td>
<td>808</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ T = 1000 \quad 604 \quad 138 \quad 81 \quad 112 \] \( \text{OP} = 43.0 \)

\[ C = 400 \quad 578 \quad 7 \quad 1 \quad 7 \quad 315 \] \( \text{CP} = 246 \text{ MPa} \)

\[ B = 1000 \quad 577 \pm 21.8 \quad 90 \quad 196 \quad 0.55 \text{ W/K} \]

Not much difference except OP value.

Ramping up on Manual to \( OP = 46.2 \)

\[
\begin{array}{ccccccccccc}
1164 & 1231 & 1255 & 1267 & 1279 & 1295 & 1313 & 1306 & 1297 \\
\end{array}
\]

\[ T = 1000 \quad 929 \quad 22.1 \quad 8.6 \quad 190 \]

\[ C = 600 \quad 859 \quad 255 \quad 40 \quad 102 \]

\[ B = 940 \quad 754 \quad 26.8 \quad 8.9 \quad 238 \]

\( \text{CP} = 270 \text{ MPa} \)

Not too hot at top compared to previous run, so adjust gradient.

\[
\begin{array}{ccccccccccc}
1261 & 1313 & 1325 & 1338 & 1321 & 1323 & 1321 & 1322 & 1305 & 1318 \\
\end{array}
\]

\[
\begin{array}{ccccccccccc}
1298 & 1362 & 1374 & 1375 & 1374 & 1375 & 1376 & 1358 & 1269 \\
\end{array}
\]

\[ T = 950 \quad 778 \quad 21.6 \quad 8.1 \quad 175 \]

\[ C = 700 \quad 939 \quad 27.6 \quad 40 \quad 110 \]

\[ B = 1000 \quad 855 \quad 30.7 \quad 9.2 \quad 282 \]

\( \text{OP} = 45.7 \)

\( \text{CP} = 276 \text{ MPa} \)

\[
\begin{array}{ccccccccccc}
1465 & 1511 & 1526 & 1525 & 1525 & 1529 & 1535 & 1529 & 14 \\
\end{array}
\]

\[
\begin{array}{ccccccccccc}
1432 & 1509 & 1528 & 1528 & 1527 & 1527 & 1526 & 1494 \\
\end{array}
\]

\[ T = 950 \quad 1105 \quad 24.1 \quad 8.0 \quad 193 \]

\[ C = 760 \quad 1063 \quad 30.2 \quad 3.9 \quad 118 \]

\[ B = 1000 \quad 987 \quad 35.7 \quad 8.8 \quad 314 \]

\( \text{OP} = 45.0 \)

\( \text{CP} = 284 \text{ MPa} \)

Now dropping a bit more relatively at top.

After \( \frac{1}{2} \) hr at \( 940 \)

\[
\begin{array}{ccccccccccc}
1498 & 1518 & 1518 & 1516 & 1517 & 1517 & 1492 & 960 / 760 / 1000 \quad \text{OP} = 45.0 \\
\end{array}
\]

\( \text{B} = 993 \quad 628 \quad 0.51 \text{ W/K} \)
Axial LVDT : D5/100K

AXIAL PBS LVDT was set with the body almost flush with the top of the anvil piece.
Should have been set at min. 2 mm about 2 mm below surface of anvil.
Assembly of LVDT load cell (from p.74)

Torsion LVDT load: 25/25k

At electrical zero \( X = 28.0 \)

Set at 1.5

Cut threaded end off core, leaving 17.6 of core.

Net at Thrust setting of LVDT.
Wiring for direct access to LVDT outputs:

IF white positive, green negative
IT brown " blue "
AD grey " pink "

Had to fit LVDT loadcell body to bottom plug by chamfering splines
Testing LVDT load cell

Excitation 5.18 V

\[ IF \text{ output from LVDT} = 300 \text{ mV} \]
\[ IF \text{ voltage} = 6.15 \text{ V} \]
\[ IT = 10.99 \text{ V} \]

Not emission under...

Adjusting LCS on mV AC output:

\[ IT = 962 \text{ mV} \]

Moved both cores to extreme,

\[ IT = 768 \text{ mV} \]

\[ 568 \text{ mV} (1004 \text{ mV}) \]

\[ 0.8 + 0.75 \text{ mm} \]

\[ 1.55 \text{ mm} \]

\[ \frac{486 \text{ mV}}{281 \text{ mV/mm}} \]
\[ 140.6 \text{ mV/mm for 1 LVDT} \]
\[ ie \ 27 \text{ mV/V/mm} \]

Compared with 43 = nominal travel.

IF = 321 mV

Any press groove will core raised to be 0.6 mm below top instead of 1mm.

Adjustment:

Dia-milled LLC again as could not get the IT reading.

Turned out that maybe a chamfer needed on core carrel (done) and the street holes in core carries in wrong place — re-assembled with one screw.

Re-assembled & now set all LVDT to give min ac voltage output, moving the two cores the same amount.

Had to reverse excitation to get all output, in right polarity.
Calibrating AD LVDT

Set zero reading at -13.25 to be zero on

Min. mV ac output at ~ 14 pos.

<table>
<thead>
<tr>
<th>Dial Gauge</th>
<th>Sine Gage</th>
<th>Volts</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.3</td>
<td>31.53</td>
<td>11.01</td>
</tr>
<tr>
<td>21.716</td>
<td>4.47</td>
<td></td>
</tr>
<tr>
<td>25.257</td>
<td>6.83</td>
<td>17 mV/18 V</td>
</tr>
<tr>
<td>-2</td>
<td>-11.36</td>
<td></td>
</tr>
<tr>
<td>3.701</td>
<td>-7.54</td>
<td></td>
</tr>
<tr>
<td>3.6</td>
<td>+11.08</td>
<td></td>
</tr>
<tr>
<td>-0.368</td>
<td>2.57</td>
<td>-10.25 V/1.70</td>
</tr>
<tr>
<td>2.214</td>
<td>-8.52</td>
<td></td>
</tr>
</tbody>
</table>

See note p 42.
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>20.039</td>
<td>16.088</td>
</tr>
<tr>
<td>19.032</td>
<td>15.008</td>
</tr>
<tr>
<td>18.053</td>
<td>13.970</td>
</tr>
<tr>
<td>17.031</td>
<td>12.880</td>
</tr>
<tr>
<td>16.029</td>
<td>11.812</td>
</tr>
<tr>
<td>15.013</td>
<td>10.740</td>
</tr>
<tr>
<td>14.032</td>
<td>9.716</td>
</tr>
<tr>
<td>13.006</td>
<td>8.644</td>
</tr>
<tr>
<td>12.045</td>
<td>7.630</td>
</tr>
<tr>
<td>11.006</td>
<td>6.532</td>
</tr>
<tr>
<td>9.995</td>
<td>5.452</td>
</tr>
<tr>
<td>8.960</td>
<td>4.328</td>
</tr>
<tr>
<td>9.984</td>
<td>5.432</td>
</tr>
<tr>
<td>10.998</td>
<td>6.515</td>
</tr>
<tr>
<td>12.006</td>
<td>7.580</td>
</tr>
<tr>
<td>13.055</td>
<td>8.656</td>
</tr>
<tr>
<td>14.005</td>
<td>9.678</td>
</tr>
<tr>
<td>15.020</td>
<td>10.736</td>
</tr>
</tbody>
</table>

**Note:**
Reset

Total:

Paul has decided to use limit switches to be all N.O. - opening wire break device.

Problem when checking limits - amplifier not enabling?

Need to ground the enable pos & enable neg inputs.
LVDT Load Cell (cont’d)

Decided to change IF Y17 Eurotherm inputs from
the RS cards to ±10V instead of mA because with
running ±10V instead of ±5V from the RS cards we
would need +20 mA to run current and the Eurotherm
will only take ±0 – ±20 mA.

This means that to go back to the SG load cell, the
4D voltage output would have to be connected to
the Eurotherm instead of current output.

IF zone fitting: Z2 + Z3
AD: Z2 + Z3

Set AD to read 14.000 at P05 14 using Z2 a RS card.

AD Calibration

Dial gauge in centre of its range at 14.0

<table>
<thead>
<tr>
<th>Eurotherm</th>
<th>Dial Gauge</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.001</td>
<td>10.000</td>
<td>14.0</td>
</tr>
<tr>
<td>14.993</td>
<td>10.772</td>
<td></td>
</tr>
<tr>
<td>20.011</td>
<td>14.786</td>
<td></td>
</tr>
</tbody>
</table>

Still too much gain on minimum span.

So short input to channel B and take (A+B)/2
and output → saturates at about ±9 mm — need to put (A+B in series

<table>
<thead>
<tr>
<th>Eurotherm</th>
<th>Dial Gauge</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.986</td>
<td>10.325</td>
<td></td>
</tr>
<tr>
<td>15.325</td>
<td>11.040</td>
<td></td>
</tr>
<tr>
<td>15.306</td>
<td>11.040</td>
<td>0.955</td>
</tr>
<tr>
<td>19.088</td>
<td>14.975</td>
<td></td>
</tr>
<tr>
<td>19.260</td>
<td>14.975</td>
<td></td>
</tr>
<tr>
<td>15.126</td>
<td>10.856</td>
<td></td>
</tr>
<tr>
<td>14.000</td>
<td>9.672</td>
<td></td>
</tr>
<tr>
<td>14.992</td>
<td>10.708</td>
<td></td>
</tr>
<tr>
<td>16.013</td>
<td>11.786</td>
<td></td>
</tr>
<tr>
<td>16.995</td>
<td>12.828</td>
<td></td>
</tr>
<tr>
<td>18.008</td>
<td>13.910</td>
<td></td>
</tr>
<tr>
<td>19.011</td>
<td>14.976</td>
<td></td>
</tr>
<tr>
<td>19.957</td>
<td>15.988</td>
<td></td>
</tr>
<tr>
<td>21.033</td>
<td>17.128</td>
<td></td>
</tr>
</tbody>
</table>
Earthworks are now set for:

Recorder:
1. POS set -1.3 to 0 V, it -1.1 to 0 V, 2 V FS.
2. IF \(\pm 50 kN\), -1 to +4 V, 5 V range = \(\frac{25}{25} kN\) FS.
3. EF \(\pm 100 kN\), -1 to +4 V, 5 V range = \(\frac{50}{50} kN\) FS.
**Calibrating LVDT LLC for IF**

Spring in 3.77 mm for 100 kN  
1.885 " 50 kN  
1.131 " 30 kN

Contact point ~ 13.3

Run a cycle ~ from the displacement, calculated 10.2 kN from spring but registered 7.1 kN on EF  
= 0.266 mm  
= 0.120 mm of extra compliance — hard to imagine this as reversible take-up in the nut.

To them with leak at bottom plug; took out, looked at O-rings etc — seemed OK; put back; takes 8 kNs OK.

<table>
<thead>
<tr>
<th>POS</th>
<th>IF</th>
<th>EF</th>
<th>CP</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.383</td>
<td>-0.41</td>
<td>0.8</td>
<td>0</td>
</tr>
<tr>
<td>12.943</td>
<td>-0.34</td>
<td>1.2</td>
<td>18</td>
</tr>
<tr>
<td>13.353</td>
<td>-0.66</td>
<td>0.8</td>
<td>0</td>
</tr>
<tr>
<td>12.944</td>
<td>-0.71</td>
<td>1.1</td>
<td>15</td>
</tr>
<tr>
<td>12.662</td>
<td>-0.46</td>
<td>-0.1</td>
<td>&quot;</td>
</tr>
<tr>
<td>12.660</td>
<td>-0.51</td>
<td>0.0</td>
<td>&quot;</td>
</tr>
</tbody>
</table>

After first flush, backed off.

After cycle to ~ 18 kN & back  
-46.1

-7.16 a few minutes later; back off position  
-60.2

Another cycle  
-62.0

Another cycle  
-62.7

Another cycle  
-64.7

-7.63

-7.67

-7.68

-7.63
<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Value</th>
<th>Method</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.058</td>
<td>-7.44</td>
<td>1.1</td>
<td>96.176</td>
<td>-65.7</td>
</tr>
<tr>
<td>13.325</td>
<td>-6.10</td>
<td>2.5</td>
<td>0</td>
<td>-106.9</td>
</tr>
<tr>
<td>13.258</td>
<td>7.50</td>
<td>1.0</td>
<td></td>
<td>-118.0</td>
</tr>
</tbody>
</table>

End of day.

---

Spring still in.

To this is off 30% but spring measurements at 1.31 seem to indicate a factor of ~7 off!

Next morning, 14C reading -5.05 at zero pressure.
<table>
<thead>
<tr>
<th></th>
<th>Gain</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>26.76</td>
<td>20.6</td>
</tr>
<tr>
<td>2</td>
<td>20.912</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>16.481</td>
<td></td>
</tr>
</tbody>
</table>
Axial LVDT cal check at atmospheric pressure.

<table>
<thead>
<tr>
<th>Evo</th>
<th>D.S.</th>
<th>scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.026</td>
<td>2.672</td>
<td>125</td>
</tr>
<tr>
<td>13.024</td>
<td>3.586</td>
<td>0.702</td>
</tr>
<tr>
<td>15.108</td>
<td>4.802</td>
<td>0.124</td>
</tr>
<tr>
<td>16.010</td>
<td>5.614</td>
<td>0.672</td>
</tr>
<tr>
<td>18.010</td>
<td>7.615</td>
<td>2.605</td>
</tr>
<tr>
<td>19.944</td>
<td>9.542</td>
<td>3.282</td>
</tr>
<tr>
<td>22.027</td>
<td>10.640</td>
<td></td>
</tr>
<tr>
<td>23.000</td>
<td>12.596</td>
<td></td>
</tr>
<tr>
<td>23.626</td>
<td>13.740</td>
<td></td>
</tr>
<tr>
<td>23.642</td>
<td>14.600</td>
<td></td>
</tr>
<tr>
<td>23.654</td>
<td>13.484</td>
<td></td>
</tr>
<tr>
<td>23.028</td>
<td>12.633</td>
<td></td>
</tr>
<tr>
<td>21.982</td>
<td>11.612</td>
<td></td>
</tr>
<tr>
<td>20.041</td>
<td>9.675</td>
<td></td>
</tr>
<tr>
<td>18.020</td>
<td>7.695</td>
<td></td>
</tr>
<tr>
<td>16.032</td>
<td>5.622</td>
<td>0.45</td>
</tr>
<tr>
<td>15.032</td>
<td>4.660</td>
<td>0.017</td>
</tr>
<tr>
<td>14.034</td>
<td>3.682</td>
<td>-0.645</td>
</tr>
<tr>
<td>12.994</td>
<td>2.658</td>
<td>-1.357</td>
</tr>
<tr>
<td>12.048</td>
<td>1.723</td>
<td>-1.970</td>
</tr>
<tr>
<td>10.990</td>
<td>0.662</td>
<td></td>
</tr>
<tr>
<td>10.117</td>
<td>15.120</td>
<td>-3.258</td>
</tr>
<tr>
<td>9.013</td>
<td>14.008</td>
<td>-3.994</td>
</tr>
<tr>
<td>8.019</td>
<td>13.008</td>
<td></td>
</tr>
<tr>
<td>7.000</td>
<td>11.984</td>
<td></td>
</tr>
<tr>
<td>6.277</td>
<td>10.623</td>
<td></td>
</tr>
<tr>
<td>6.256</td>
<td>9.978</td>
<td></td>
</tr>
<tr>
<td>6.998</td>
<td>11.972</td>
<td></td>
</tr>
<tr>
<td>8.041</td>
<td>13.020</td>
<td></td>
</tr>
<tr>
<td>8.947</td>
<td>13.980</td>
<td></td>
</tr>
<tr>
<td>12.010</td>
<td>17.008</td>
<td></td>
</tr>
</tbody>
</table>

LVDT cal still good at atmospheric pressure. Limited by saturation of amplifier—used to pull out calibrations in series.
Put in the spring — check at atmosphere pressure.

<table>
<thead>
<tr>
<th>Time</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>12:00</td>
<td>17.082</td>
</tr>
<tr>
<td>11:04</td>
<td>16.022</td>
</tr>
<tr>
<td>10:07</td>
<td>15.010</td>
</tr>
<tr>
<td>9:27</td>
<td>14.020</td>
</tr>
<tr>
<td>7:22</td>
<td>12.982</td>
</tr>
<tr>
<td>9:26</td>
<td>14.976</td>
</tr>
<tr>
<td>12:03</td>
<td>17.034</td>
</tr>
</tbody>
</table>

Run at atmosphere pressure, contact spring 13.2

Loading on spring at O'range change WDT cal.

-13.073 3.024 -2.05
13.210 3.215 -4.96
13.279 3.676 -4.54
13.417 3.894 -2.77
13.709 4.218 1.68
13.525 4.022 -1.03
13.393 3.875 -4.55
13.282 3.732 -5.02
13.207 3.192 -5.06
13.059 3.018 -5.06

Touched spring:

<table>
<thead>
<tr>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.060</td>
</tr>
<tr>
<td>13.496</td>
</tr>
<tr>
<td>13.987</td>
</tr>
<tr>
<td>14.983</td>
</tr>
<tr>
<td>16.031</td>
</tr>
<tr>
<td>17.019</td>
</tr>
<tr>
<td>17.975</td>
</tr>
<tr>
<td>19.028</td>
</tr>
<tr>
<td>20.029</td>
</tr>
</tbody>
</table>

Presence of spring even its weight does not affect cal.
Turned around the spring \( \frac{1}{2} \) 90° and pushed it down again.

\[ \begin{array}{cccc}
12:987 & 12:985 & 12:985 & \text{not sure.}
\end{array} \]

Run at \( \frac{1}{2} \) m/s pressure:

<table>
<thead>
<tr>
<th>Run</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>IT</th>
</tr>
</thead>
<tbody>
<tr>
<td>13:062</td>
<td>4.462</td>
<td>-5.01</td>
<td>0.6</td>
<td>-72.8</td>
</tr>
<tr>
<td>13:239</td>
<td>4.652</td>
<td>-4.93</td>
<td>0.8</td>
<td>-72.6</td>
</tr>
<tr>
<td>13:282</td>
<td>4.980</td>
<td>-4.73</td>
<td>1.4</td>
<td>-72.5</td>
</tr>
<tr>
<td>13:458</td>
<td>5.388</td>
<td>-2.64</td>
<td>5.4</td>
<td>-76.2</td>
</tr>
<tr>
<td>13:104</td>
<td>5.548</td>
<td>-0.44</td>
<td>9.0</td>
<td>-76.6</td>
</tr>
<tr>
<td>13:743</td>
<td>5.692</td>
<td>-1.69</td>
<td>12.5</td>
<td>-74.4</td>
</tr>
<tr>
<td>13:585</td>
<td>5.538</td>
<td>-0.58</td>
<td>8.4</td>
<td>-76.7</td>
</tr>
<tr>
<td>13:430</td>
<td>5.372</td>
<td>-2.92</td>
<td>4.6</td>
<td>-78.3</td>
</tr>
<tr>
<td>13:292</td>
<td>5.152</td>
<td>-4.64</td>
<td>1.5</td>
<td>-75.6</td>
</tr>
<tr>
<td>13:263</td>
<td>4.842</td>
<td>-4.90</td>
<td>0.8</td>
<td>-78.9</td>
</tr>
<tr>
<td>13:051</td>
<td>4.458</td>
<td>5.00</td>
<td>0.5</td>
<td>-78.2</td>
</tr>
</tbody>
</table>

Repeats previous run orientation of spring does not matter.

Run at 28 MPa:

\[ \begin{array}{cccc}
12:542 & 4.542 & -5.50 & 0.7 & -68.3 & 7
12:546 & 4.450 & -5.63, 557 \ldots & 0.9 & -68.0 & 14
12:551 & 4.448 & -5.15 \ldots & 1.2 & -63.5 & 24
12:836 & 4.722 & -4.34 & 1.3 & -65.2 & 25
13:384 & 45.275 \ldots & -3.72 & 2.4 & -66.5 \ldots
13:388 & 5.442 & -1.79 & 6.0 & -71.3 \ldots
13:666 & 5.580 & 0.09 & 9.2 & -71.9 \ldots
13:800 & 5.720 & 206 & 12.6 & -70.5 \ldots
13:718 & 5.640 & 0.94 & 8.6 & -71.9
13:555 & 5.478 & \ldots & 4.7 & -74.6
13:414 & 5.318 & -3.50 & 1.2 & -73.1 \ldots
13:247 & 5.140 & -4.26 & -0.5 & -69.5
13:049 & 4.945 & -4.31 & -0.6 & -69.7
13:050 & 4.948 & \ldots & -0.6 & -72.1
\end{array} \]

Note on reading:

The run 13.050 cycle was an interrupted.
0.408 mm for 9.6 kN → 4.25 mm/100 kN
0.385 " 9.6 " → 4.01 "
Pumped up to **4.6 MPa**

<table>
<thead>
<tr>
<th>Time</th>
<th>Pressure</th>
<th>Load</th>
<th>Bending</th>
<th>Drift</th>
</tr>
</thead>
<tbody>
<tr>
<td>13:053</td>
<td>-9.16</td>
<td>-0.2</td>
<td>-85.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>IF gage changed 4.9 to -9.2 drifting down</td>
</tr>
<tr>
<td>Ran 2 cycles to ~17 kN</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13:100</td>
<td>-9.69</td>
<td></td>
<td>-85.9</td>
<td></td>
</tr>
</tbody>
</table>

Pumped up to **100 MPa**

<table>
<thead>
<tr>
<th>Time</th>
<th>Pressure</th>
<th>Load</th>
<th>Bending</th>
<th>Drift</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IF gage went down to -11 kN, then drifting up later down</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IF ~ -14.63</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Dropping pressure to **25 MPa**

<table>
<thead>
<tr>
<th>Time</th>
<th>Pressure</th>
<th>Load</th>
<th>Bending</th>
<th>Drift</th>
</tr>
</thead>
<tbody>
<tr>
<td>13:039</td>
<td>4.288</td>
<td>-14.4</td>
<td>-0.3</td>
<td>-94.9</td>
</tr>
</tbody>
</table>

Ran 2 cycles, then

<table>
<thead>
<tr>
<th>Time</th>
<th>Pressure</th>
<th>Load</th>
<th>Bending</th>
<th>Drift</th>
</tr>
</thead>
<tbody>
<tr>
<td>13:060</td>
<td>4.950</td>
<td>-11.1</td>
<td>0.1</td>
<td>-88.6</td>
</tr>
<tr>
<td>13:041</td>
<td>5.328</td>
<td>-10.25</td>
<td>3.1</td>
<td>-88.1</td>
</tr>
<tr>
<td>13:555</td>
<td>5.450</td>
<td>-8.78</td>
<td>5.8</td>
<td>-91.0</td>
</tr>
<tr>
<td>13:699</td>
<td>5.600</td>
<td>-6.68</td>
<td>9.4</td>
<td>-91.2</td>
</tr>
<tr>
<td>13:826</td>
<td>5.736</td>
<td>-4.73</td>
<td>12.7</td>
<td>-89.1</td>
</tr>
<tr>
<td>13:650</td>
<td>5.555</td>
<td>-7.19</td>
<td>6.3</td>
<td>-91.8</td>
</tr>
<tr>
<td>13:407</td>
<td>5.296</td>
<td>-10.37</td>
<td>0.5</td>
<td>-88.2</td>
</tr>
<tr>
<td>13:090</td>
<td>4.972</td>
<td>-10.75</td>
<td>-0.5</td>
<td>-86.5</td>
</tr>
<tr>
<td>13:090</td>
<td>4.973</td>
<td>-10.70</td>
<td>0.4</td>
<td>-86.4</td>
</tr>
</tbody>
</table>

Back to zero pressure

<table>
<thead>
<tr>
<th>Time</th>
<th>Pressure</th>
<th>Load</th>
<th>Bending</th>
<th>Drift</th>
</tr>
</thead>
<tbody>
<tr>
<td>13:096</td>
<td>4.478</td>
<td>-10.14</td>
<td>0.6</td>
<td>-80.9</td>
</tr>
<tr>
<td>13:322</td>
<td>5.120</td>
<td>-9.74</td>
<td>1.8</td>
<td>-81.5</td>
</tr>
<tr>
<td>13:469</td>
<td>5.385</td>
<td>-7.89</td>
<td>5.3</td>
<td>-85.4</td>
</tr>
<tr>
<td>13:641</td>
<td>5.570</td>
<td>-5.33</td>
<td>9.6</td>
<td>27 kN 20.90 -82.0</td>
</tr>
<tr>
<td>13:778</td>
<td>5.716</td>
<td>-3.19</td>
<td>13.0</td>
<td>-82.8</td>
</tr>
<tr>
<td>13:629</td>
<td>5.568</td>
<td>-5.29</td>
<td>9.1</td>
<td>-85.0</td>
</tr>
<tr>
<td>13:467</td>
<td>5.395</td>
<td>-7.75</td>
<td>5.0</td>
<td>11.22 kN 0.422 -87.1</td>
</tr>
<tr>
<td>13:331</td>
<td>5.228</td>
<td>-9.60</td>
<td>1.8</td>
<td>-85.1</td>
</tr>
<tr>
<td>13:080</td>
<td>4.470</td>
<td>-10.12</td>
<td>0.5</td>
<td>-81.7</td>
</tr>
</tbody>
</table>
Recently:

IF: -3.5 to 1.5 \& 5V FS = 25LN FS

EF: -1 to 4 \& 5V FS = 50kN FS

Need to change IF to 10V FS to get 50kN FS.

Change to 10V FS on IF: -3 to +7
Summary

D-1LVDT calibration is OK against dial gauge at gauge pressure this morning but it seemed to be 3% off after yesterday's 100 kPa run in which the LVDT seemed to be further off — apparent spring constant 0.58 mm/100 kPa ± EF.

Today apparent spring constant is ~ 3.9 mm/100 kPa ± EF.

Have been misled thinking AD scale was 1.5 mm, was actually 2.25 m (1.5V).

LVDT behaviour seems to be fairly good.

Internal Force

IF calib is now by a factor of 1.71 at 0 MPa
1.83 25 "
1.83 50 "
1.79 100 "
1.72 25 "
1.72 0 "
ave 1.77

Re-set zero of IF to around -6.
Adjusted span of IF at 0 MPa to agree EF.

Adjusted span of IF at 100 MPa to give 50 KN/F.

Task out IL C.
Paul to wire AD LVDT's excitation in series.

He also finished wiring axial motor amplifier for over-riding limits.

When assembling IL C again, torsion output seemed to balance out at a lower figure (near 10 V) + ± EF you came back to ~40.
Touch yoke at 0.5

AD range is now ±5V

Can get back to ±10V if remove (A+B)/2 linkages

[Signature]

[Date] 05/20

0.74

0.112

20.05-2

0.112

19.940
Checking alarms.
Bottom position on actuator trips out at -18° — OK.
Position alarms high & low OK.
IF alarm OK
RF alarm OK.

New position of AD zero has shifted when re-connecting
WDT's with excitation in series.

Ran up to position 15, when Emro read ~ 14.5
Emro Scale

AD readings saturate at 23.6 still.
Changed gain jumpers to 100-300 mV/V and re-tested at 15°
It seems to saturate at ~ 5.7 V or so
Changed Emro trimmer to ±5 V range.

<table>
<thead>
<tr>
<th>Emro</th>
<th>D4</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.996</td>
<td>0.676</td>
</tr>
<tr>
<td>0.567</td>
<td>19.480</td>
</tr>
<tr>
<td>20.052</td>
<td>5.620</td>
</tr>
<tr>
<td>25.052</td>
<td>10.475</td>
</tr>
<tr>
<td>20.997</td>
<td></td>
</tr>
<tr>
<td>5.057</td>
<td>5.788</td>
</tr>
<tr>
<td>5.003</td>
<td>0.684</td>
</tr>
<tr>
<td>Euro</td>
<td>DG</td>
</tr>
<tr>
<td>-------</td>
<td>------</td>
</tr>
<tr>
<td>15.023</td>
<td>0.682</td>
</tr>
<tr>
<td>16.063</td>
<td>1.736</td>
</tr>
<tr>
<td>18.027</td>
<td>3.715</td>
</tr>
<tr>
<td>20.022</td>
<td>5.728</td>
</tr>
<tr>
<td>24.077</td>
<td>9.762</td>
</tr>
<tr>
<td>25.008</td>
<td>10.686</td>
</tr>
</tbody>
</table>

26.022 11.730
25.948

AD calib is again OK.

IF calib

Required with $Z_1 + Z_2 + Z_3$ goes off scale ($> -11V$)

$Z_1 + Z_2$ at $> -11V$

$Z_3$ at $> -11V$

Zero off scale — needs repositioning of cores.
RDP: 0.78 V per V at 12.5 mm.

0.78 x 2.5 x 2 = 0.975 V at 12.5 mm
25/6/99

Took out 1LC.

Changed AD card back to A output from (A+B)/2 and changed Eurotherm back to ±10V input.

Installed outlets for measuring LVDT signals from 1LC for adjustment.

Adjusted IF core positions to minimize LVDT signal.

Re-installed 1LC.

Calib. AD

| 14:48:02 | 1.530 |
| 20:01:00 | 6.550 |

Cannot get past 22° PDS, when output V = 46 and input was ~ 22V ac. Seems that core is way out of position. Now at PDS 15 we get 2°...V ac instead of few hundred mV.

<table>
<thead>
<tr>
<th>LVDT raw signal</th>
<th>Output from amp</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>2.42 V</td>
</tr>
<tr>
<td>5.2</td>
<td>1.36 V</td>
</tr>
<tr>
<td>7.6</td>
<td>0.26 V</td>
</tr>
<tr>
<td>9.3</td>
<td>0.160 V</td>
</tr>
<tr>
<td>11.0</td>
<td>0.69 V</td>
</tr>
<tr>
<td>15.0</td>
<td>2.05 V</td>
</tr>
<tr>
<td>20.0</td>
<td>3.75 V</td>
</tr>
<tr>
<td>22.5</td>
<td>4.64 V</td>
</tr>
</tbody>
</table>

Turns out that the comp. piston had got unscrewed somehow during assembly, probably due to turning the screw on the bottom end of the comp. piston to lower or raise the yoke.

Re-assembled.

Still a problem with piston seeming not to be screwed in.

Take out again.
Rod projects 11mm when comp piston properly onto main piston.

Need for care in assembling comp piston on HIC piston to have thing together I watch while doing up assembling joke etc.

1. H.D. –20 to –1.9 to 1.15 → 0.75V ≃ £22.25mN FS
2. IF –2 to +8 → 10V ≃ 50 kN FS
3. EF –1 to +1 → 5V ≃ 50 “
4. IT –5 to +5 → 10V ≃ “500 Nm FS”
5. CP 0 to 7.14 → 500 MPa
6. TP –1 to +1 → 2V ≃ 0.14

Present handle on top door gets in way of tension actuator — needs to be lower profile, as formerly
The screw joining comp. & load cell pistons was broken.
- too much force or big spanner or accidental downward move.
Cut it through fractured. Thinned one piece down to 4 mm & put in bottom of threaded in comp piston, & used other part for joining - about 1½ threads each side.

Re-assembled.

Recal:

<table>
<thead>
<tr>
<th>Data</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.98</td>
<td>1.334</td>
</tr>
<tr>
<td>16.019</td>
<td>2.350</td>
</tr>
<tr>
<td>20.031</td>
<td>6.434</td>
</tr>
<tr>
<td>21.007</td>
<td>7.428</td>
</tr>
<tr>
<td>25.056</td>
<td>11.460</td>
</tr>
<tr>
<td>26.020</td>
<td>12.452</td>
</tr>
</tbody>
</table>

Resubmission.

Recal:

<table>
<thead>
<tr>
<th>Data</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.98</td>
<td>1.334</td>
</tr>
<tr>
<td>16.019</td>
<td>2.350</td>
</tr>
<tr>
<td>20.031</td>
<td>6.434</td>
</tr>
<tr>
<td>21.007</td>
<td>7.428</td>
</tr>
<tr>
<td>25.056</td>
<td>11.460</td>
</tr>
<tr>
<td>26.020</td>
<td>12.452</td>
</tr>
</tbody>
</table>

IF Cal.

IF zin = -5.92
IT = 101.6

Various runs adjusting span & zero.

Arrived at Z2 = 0.2 at 0 pressure

100 MPa

Z = -5 kN won.

Calib was 48.5 up, 51.4 down, ange 50.0, then being some drift of the zero during calibration.

6:10 Z = -8.47
CP = 96 MPa
13:215 IT = 57.2
8:00 Z = -9.24
96
13:215 59.7

Pumping up to 300 MPa - leak at 40.3.

Z = -15.8

Run a cycle
Z = -15.50

Run several XY plots
Dropped back to 100 MPa
Zero back to -8.7
AD dropped 9 div to 0.2 mm.
After 10 mins - 80, Z = -7.76

Some noise on AD, which also seemed to be on the LUDT raw signal.

Dropped to 0 MPa; after 10 mins - 80, IT = -0.56, AD = 2.169
10:20 pm 10.740 -9.95 0.2 41.9 10.905 -2.00 0.2 45.3 | That morning 393
5.8 ± 0.6 V
5 ± 0.4 V

```
\[ E_{\text{rel}} = 263.0 \]
\[ E_{\text{black}} = 263.4 \]
\[ E_{\text{black}}' = 263.3 \]
\[ E_{\text{black}}'' = 263.4 \]
```

---

**Wiring of ETC not correct - corrected.**

**Ex 5.13**

\[ V_{\text{sig}} = 5 \pm 0.4 \]

\[ \text{Output} = 10 \cdot \frac{350.5}{350 + R} - 5 = 0.0014 V \]

\[ \frac{\Delta V}{350 + R} = 0.5 - 0.0014 \]

\[ R = 0.196 \Omega \]

\[ \frac{1}{350.196} = \frac{1}{350} + \frac{1}{\Delta R} \]

\[ \Delta R = 625,175 \]

*ie* \[ \Delta R = 625 k\Omega \]

To connect across white/black.
Tension System

ETC : Resistances  
Ex red - Sig Wh  ❄️ 263.0
    "  Sig Gr  ❄️ 263.0
    "  E Black  ❄️ 263.4

Sig Wh - Sig Gr  ❄️ 350.5
    "  E Black  ❄️ 263.4

Sig gr - E Black  ❄️ 263.3

Paul to revise wiring

Contact ~ 85106

Cannot give an voltage; need a 625-000 SC trimming on bridge.
Paul’s wiring for RVDT (Hoch Letters)

Using 3B17-03 (new one bought in Germany on
grounds that stb previous ones 3B17-6 plus
resistors at back), which were deemed not to work)

Check with excit in on yellow/brown & signal out on red/black (with excit alone) can zero & get ~900mV @ 30°.

Revised RVDT connection as:

Did not work

Back to original wiring

Confused problem with RVDT
RVDT

Problem with large offset -5V at GREEN-WHITE, compared to -14V or so on V output of 3817.
Excitation is 5V.
Check zero volt when exc. disconnected.
Set RVDT to zero position.
We were getting -14V output.
Mess around for several hours & then nominally restored the original wiring, as above left.
Then RVDT worked OK.

Across GREEN - BLACK set 5V ± few tenths
WHITE - BLACK ±0 ± ~1V

For RVDT
O RED
O WHITE changed to { O RED
O GREEN
O WHITE
O BLACK

{ did not work for changing polarity

The RVDT is working but polarity of twist is reversed.
Set RVDT to read +10V and 0 radians at -40°

0
+40°
-40°

-1.4
-0.7

0
+10°

NB
\[ M = 2787 \left( \theta_1 - \theta_2 \right) \]

1000 Nm would give \( \theta_1 - \theta_2 = 0.0359 \), say \( \theta_1 = 0.04 \)

Ch. 6 = TP, -1V to +1V i.e. 0.7 - 0.07 to 0.7 + 0.07

At 0.689, \( \Delta T = 0.01 \), i.e. \( \Delta \theta \approx 25 \text{ Nm} \)

\[ \text{dead} \, 0.711 \pm 0.006 \]

No excitation in 3B18 on ET — no excitation at the exc terminals; all other 3B18's OK; seemed to be a fault in the 3B backplane.
Calibrating Torques

\[ \text{Set the twist at } 0.7 \text{, gear 1:1} \]

<table>
<thead>
<tr>
<th>T</th>
<th>IT</th>
<th>ET</th>
<th>IF</th>
<th>CP</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.701</td>
<td>52.4</td>
<td>-2</td>
<td>-10.57</td>
<td>0</td>
</tr>
<tr>
<td>0.701</td>
<td>53.3</td>
<td>-2</td>
<td>-11.7</td>
<td>8</td>
</tr>
<tr>
<td>0.700</td>
<td>53.4</td>
<td>-2</td>
<td>-10.9</td>
<td>14</td>
</tr>
<tr>
<td>0.700</td>
<td>49.1</td>
<td>-2</td>
<td>-10.9</td>
<td>100</td>
</tr>
</tbody>
</table>

Tried moving 3.65 to pos 0.692, reversed possibly contact in negative direction at \( \sim 0.699 \)

0.705 indicated on way up
\( \sim 0.717 \) contact up
Speed \( \sim 132 \)
Contact \( \sim 0.705 \) down

By comparing twist derived torque with observed internal torque, set the torque calibration approximately at 100 MPa. Much the same calibration (within 1% of 50) at 300 MPa.

But IT zero moved substantially, \( \sim 100 \) Nm, from zero pressure to 300 MPa.

IF zero also moved down as we pumped up.

After dropping pressure:
10.765
-15.72
0.5
0.710
-19.4

Next morning:
11.055
-18.5
0.6
0.710
21.0
When power down, then power up with pressure up, comes up with door unlocked. When system power just on (switch by Bourdon gauge), door locks.

ET bridge shorted to earth at the stem.

Changed CP to ET connected to CH 5 on recorder.

-3 to +7, -10V range.

Torque amplifier needs an inrush protector.
External Torque

No excitations when ET 3818 module plugged in.

Incitation terminal 1 is earthed. So excitation is shorted out.

① red

②

③

④ checked back & line out of ET stem is shorted to earth.

⑤ [Diagram]

Opened back of driver piece; found that red wire was pitched on to the thread at bottom of stem with a tie. Removed tie, pulled wire away & put another tie higher up. Still a bare wire showing through the insulation.

Short now cured.

Exchanged green & white signal connections to get correct polarity of ET.

From p. 107, kept in trimming resistor of 619 800 Ω across white-black. Closely zero-ed bridge.

Pumped up to 100 MPA & settled down. Put ET V and AIC at 0.

New IT (Ewe) = -55.0
<table>
<thead>
<tr>
<th>Euro</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.4</td>
<td>7</td>
</tr>
<tr>
<td>11.6</td>
<td>8</td>
</tr>
<tr>
<td>11.7</td>
<td>9</td>
</tr>
<tr>
<td>11.8</td>
<td>10</td>
</tr>
<tr>
<td>12.0</td>
<td>11</td>
</tr>
<tr>
<td>12.1</td>
<td>12</td>
</tr>
<tr>
<td>12.2</td>
<td>13</td>
</tr>
<tr>
<td>12.4</td>
<td>14</td>
</tr>
<tr>
<td>12.6</td>
<td>15</td>
</tr>
</tbody>
</table>

Excitation OK. 1.0 V when RS amplift not connected.

AC output = 0.565 V at POS = 15 with RS amplift connected.
0.537

With all AP, IT & IT unplugged:

\[ AP = -0.511 \text{V} \]
\[ IF = 0.852 \text{V} \]
\[ IT = 4.316 \text{V} \]

AP with excitation, new AP = \[ -0.472 \text{V} \], no signal input.
\[ AP = -1.614 \text{V} \] with signal connected.

<table>
<thead>
<tr>
<th>Scale</th>
<th>Volt input to RS</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>0.563</td>
</tr>
<tr>
<td>16</td>
<td>0.516</td>
</tr>
<tr>
<td>17</td>
<td>0.472</td>
</tr>
<tr>
<td>18</td>
<td>0.428</td>
</tr>
<tr>
<td>19</td>
<td>0.388</td>
</tr>
<tr>
<td>20</td>
<td>0.342</td>
</tr>
<tr>
<td>21</td>
<td>0.300</td>
</tr>
<tr>
<td>22</td>
<td>0.254</td>
</tr>
<tr>
<td>23</td>
<td>0.212</td>
</tr>
<tr>
<td>24</td>
<td>0.169</td>
</tr>
<tr>
<td>25</td>
<td>0.124</td>
</tr>
<tr>
<td>26</td>
<td>0.076</td>
</tr>
<tr>
<td>27</td>
<td></td>
</tr>
</tbody>
</table>
The RDP LVDT appeared to have open-circuited on the first run to 300 MPa. The swivel noise was present at 100 MPa and was completely gone at 0 MPa.

\[ EF \gamma_0 = 0.3 \]
Change to Single AD LVDT

After much thought & measurement, took out load cell & established open circuit in one secondary winding in one AP LVDT. Shorted it out, so as to operate with one LVDT.

Re-installed, again setting 1F & 1T corrs at min ac output.

Euros 2G
14.998 9.998
16.038 10.008
17.048 18.000
20.048 14.960
23.064 17.900
25.047 read 19.812
24.822 19.812
24.070 19.984 19.054
23.042 18.072
21.005 16.050
18.054 15.075
16.065 11.072
15.029 10.040
12.012 7.042
8.045 3.032  AD Calib OK.

Then at atmos. pressure on spring, 1F cal still OK, but a lot of invariable zero drift on 1T.

1:1 LVDT drive
At 0.176, 1F = 1.06  1T = 136.8.
Less drift of 1F zero with pressure to 100 KPa than before, but 1T zero seems more drift.
1T cal. still more or less OK.
Zero seemed steady after cycling (then wore a torque on the rod beforehand).
Drift not too bad on pressure release.

Next morning: 1F zero = 2.91
1T = 139.5
No hole for thermocouple and por fluid connection in connector on end of torsion driver and in connector at top.

\[ \dot{\theta} = \frac{d\theta}{2L}. \]

\[ \theta = \frac{2L}{d} \]

\[ = \frac{2.25 \cdot 7.8}{10} \]

\[ \theta = 5.14 \] °

\[ \gamma = 0.5, \beta = 2.57 \]

\[ \gamma = 0.2, \beta = 1.03 \]

Output power of 10 gives 486 µrad s⁻¹ (meter reading 268 at present).

For 1000 µrad s⁻¹, need OP = 20.6

1. AD 4V range for 600 N x 10 F/S
2. IF 2V range for 120 N x 5 F/S
3. EF 2V range for 120 N x 5 F/S
4. IT 4V range for 200 N x 2 F/S
5. FEET 4V range for 200 N x 2 F/S
6. TD 80V range for 1.4 N x 1 F/S

No 1 shutter shut in no 2; No 2 in no 1

[Turned off]

[IT altered]
Run on Carrara Marble

Had to run low in POS to accommodate specimen assembly (similar to POS for torsion bar).

\[
\begin{align*}
\text{Pos} & = 15 \quad \text{touchdown} \approx 3.3 \\
\text{Length} & = 25.7 \\
1F \times 0 & = 2.97 \\
1T & = 138.1 \\
TP & = 0.101 \\
ET & = 20
\end{align*}
\]

AD reading goes down when gas put in.

Leak at topping or piston at \( \approx 260 \, \text{MPa} \), off at \( 63 \, \text{MPa} \) on way down.

IT went off air during pumping up; came back on during pressure release.

Leak in jack due to churning against no churning.

New specimen \( \phi 15 \) Length \( 24.95 \)

\[
\begin{align*}
\text{POS} & = 62.1 \\
1F & = 3.85 \\
1T & = 125.1
\end{align*}
\]

IT measured \( 3.8 \, \text{mV} \) with bottle pressure, \( \text{POS} \rightarrow 3.136 \)

Pumped to \( 118 \, \text{MPa} \), started furnace ramping up to \( Tc \approx 750 \).

IT went off air at \( 131 \, \text{MPa} \) \( \rightarrow 17 \, \text{mV} \) \( \rightarrow \) 1273 later.

1T \& 2T at socket = 94.5 \( \Omega \) (was \( 105 \, \Omega \))

Both sides not grounded.

Torque \( TP \) = 0.095 \& 0.12, set at 0.104 for zero torque.

Remarkably linear drift.

\[
\begin{align*}
\text{Testing:} & \quad T \quad V \quad W \quad \text{for (1200 \, \Omega)} \\
1000 & \quad 8.2 \quad 20 \quad 164 \\
550 & \quad 7.4 \quad 19 \quad 57 \\
960 & \quad 7.5 \quad 28 \quad 246 \\
& \quad 0.50 \, \text{W/K}
\end{align*}
\]

1F \times 0 now \( -3.63 \), POS \( 5.28 \), TP = 0.104, ET = 10
Put individual power on/off switches on each actuator panel.

Noise on fluid LVDT when running torsion actuator.
Staining in fusion \( k \approx 2 \times 10^{-4} \) s^{-1}

IF zone still on linear drift.

Compression:

Set OP 3.0

Set 5V F/S on \( \Theta \) = 1F
10V " on \( \Theta \) = EF

IT coming back at 225 MPa, 17.7 mV a.c.

Test came back to 200 MPa and went up to T(8) = 750 K again.

IT zone = 189.9
IF zone = 6.06
AP = 4.688

Repeat torsion test further, with several changes.
External LVDT

Checked the wiring. Excitation seemed OK (5V, 7.5kHz - although frequency is above range specified by Schenley). Wiring on LVDT seemed OK but there did not seem to be a response when moving the actuator, as measured by 4V voltage output from the transducer (although it was still connected to the AD conditioning unit 3B17).

Tomorrow, should check out the circuitry with independent HR1000 transducer.

Checked again with 5V excitation into the LVDT and measured output - 35mV independent of moving the actuator 1mm, which should have given a change of 70mV. So it would appear that there is no core.

With wiring on LVDT as follows:

- red/yellow
- EXC
- black/yellow

Black
Green
Red

so there must be a core.

we get ±0.7V for ±10mm movement - OK.

We would have thought the above arrangement must be

- black/yellow
- EXC
- red/yellow

in order to work - did not. Always get ±14V.

Eventually we got some sensible readings from:

- black
- green
- blue
- red

for the independent LVDT.

Did not work with the actuator LVDT.
Switched green and white below 3817:

POS V
9.78 -11.3 drifting.
Excitation in now 4.76V (calibrating it was 5.11V).
Green-white gives 3.03V but drifting down.
Changed green/white back below 3817, no

Connected to the free LVDT
Blue/green — green
black + black/yellow — black
red LVDT — white
yellow/red — red
Core unshielded — reading 0.026 V
Core x10 mm — 2.043 V
Core -10 mm — 3.072 V

Excitation = 5.11 V.
green-white = 3.39 V or 3.072V act.
red = 0.20 V
yellow = 3.80 V

No free LVDT works with the wiring as above — same as used on actuator LVDT.
DC resistances on free LVDT:
red/gel - black/gel 92.9 primary
black - green/blue 90.3 179.7
red - green/blue 87.4
black - red 179.4

DC resistances of actuator LVDT:
red/gel - black/gel 94.6 primary
black - green/blue 91.9 184.1
red - 92.2
black - red 183.5

Excitation now 4.74 V.
Now changing wiring to Torx black off yellow/black; EXC = 4.66

Changes to:
BLACK — B/Y
RED — B/R
GREEN — WHITE
RED —
EXC = 4.65 V
3 B17 out = 0.6 V drifting

EXC = 4.71 slow down left
3 B17 out = -10.26

EXC = 4.72

EXC = 4.76

Back to the free LVDT

EXC = 5.10 V

With core centred:
- Green-white = 3.798 V
- 3 B17 out = -0.003 V

Resistance:
- Red-white: 271.3 Ω
- Green: 182.4
- Black: 92.8
- White-green: 89.4
- Black: 179.0
- Green-black: 90.2

Core-centred:
- Green-white = 3.805
- 3 B17 out = -0.041

+10 mm = 4.23
+20 mm = 4.66
+25 mm = 4.85
0 = 3.797
-10 = 3.587
-20 = 3.285
-25 = 3.035

3.797 3.797 0.39
3.587 3.403 0.28
3.285 3.020 0.26
3.035 2.844

0.012 0.003
1.853 2.931 2.93
4.425 5.778 5.78
5.858 7.893 7.89
Again connect actuator RDT

DC resistance at 3B17 terminals (3B17 removed)
- Red - white 27.8:4
- Green 18.66
- Black 95.0
- White - green 92.4
- Black 184.0
- Green - Black 92.2
But back 3B17: EXC = 4.9 but drifting down

Back to meter:

EXC = 4.66 V slowly drifting down; later 4.63 V.

POS METER V.
9.764 0.026 V
11.643 0.026 V
12.80 0.026 V.

EXC = 4.63 V.

POS Meter V (AC)
12.797 3.140
9.885 3.140

EXC = 4.63

POS Meter V (AC)
9.884 3.132
12.753 3.132
**NOTE ON CONVENTIONS**

When we draw \[ A-B \] it is understood that the two windings are wound in opposite senses.

If we draw \[ A \] it is understood that the two windings are wound in the same sense.

---

**No core**
Screws on harmonic drive 1st set

\$6\$ hole in P1 2404-4 should be \$6.4\$ mm in order to insert LUT car
Try changing EXC polarity:

<table>
<thead>
<tr>
<th>RED</th>
<th>black</th>
<th>black</th>
<th>AC meter</th>
</tr>
</thead>
<tbody>
<tr>
<td>BLACK</td>
<td>red</td>
<td>red</td>
<td></td>
</tr>
</tbody>
</table>

EXC = 4.65 V

105
12.753 0.028
9.817 0.028

rossover

Attach external LVDT:

<table>
<thead>
<tr>
<th>RED</th>
<th>black</th>
<th>black</th>
</tr>
</thead>
<tbody>
<tr>
<td>BLACK</td>
<td>10 connections</td>
<td></td>
</tr>
</tbody>
</table>

EXC = 4.65 V, drifting down without core
EXC = 5.10 V, with core
4.7 drifting down without core
5.10 V, with core half-in

So it seems as if there is no core.

Dropped the motor drive & closure plate of the actuator.
No core in the LVDT.
Also the screws holding the harmonic drive to the nut-carrier of the ball screw were loose — tightened them.

Cont'd, p 160
Volume control LVDT

18/12/97

Took off motor drive & inserted LVDT core on brass support.

Red wire broken on box connector, &

Re-wired as at left.

Now have 4.9 V exc when & LVDT not connected.

Removed 3B17 & measured resistances:

<table>
<thead>
<tr>
<th>Color</th>
<th>Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>RED-WHITE</td>
<td>332.8 V</td>
</tr>
<tr>
<td>GREEN</td>
<td>174.4 V</td>
</tr>
<tr>
<td>RED-BLACK</td>
<td>20.4 V</td>
</tr>
<tr>
<td>WHITE-GREEN</td>
<td>154.1 V</td>
</tr>
<tr>
<td>RED-BLACK</td>
<td>313.1 V</td>
</tr>
<tr>
<td>GREEN-BLACK</td>
<td>154.8 V</td>
</tr>
</tbody>
</table>

Disconnected white & green under 3B17 & measured excitation; it was 2.0 V & drifting down.

On WHITE-GREEN, = 2.7 V & drifting down.

Checked LVDT wires relative to ground - nothing grounded.

Re-wired GREEN & WHITE under the 3B17 - gives -9.1 V drifting towards zero.

Exc 1.96 drifting down.

Changing gain does not change Exc.

Changed GREEN/WHITE back again.

Exc = 205 drifting down

Voltage output = -3.9 V, drifting

Checked back on actuator LVDT - ok.

Now put actuator LVDT 3B17 into channel 9 for volume control.
LVDT: Exc ~ 3.9V, drifting & output = 14 V.

Put chart 3B17 into chart 12; Exc = 4.91 V steady

Output = -14 V.

came down when changed gain then steady.
\[ 220 = \frac{10 \times 10^3}{V} \quad 1540 - 220V = 10 \times (10^3)^2 \frac{V}{V} \]
\[ V = \frac{1540}{10220} \quad 1540 \cdot \frac{V}{230} = 6.70V \]

\[ R_1 = \frac{10 \cdot 10^3}{7 - 4.91} = 22.5 \]

\[ F_n = 5V, \quad R_1 = \frac{10.5}{7 - 5} = \frac{5}{2} = 25.8 \]

\[ R_1 = 22000 \Omega \quad 22000 = \frac{10000 \times V}{7 - V} \]

\[ 154000 - 22000V = 10 \times 10^3 \frac{V}{V} \]
\[ V = \frac{154000}{32000} = 4.81 \]
Ch9 3B17 back into Ch9 — exc 6 signal still drifting down.

Put old 7805 into Ch9 — gave exc 4.6 drifting down.
Reduced gain 3 notches — exc 4.3, still drifting down.
Later exc 4.08
Pulled out core, exc 1.03 V drifting down.

Put back 3B17 into Ch9 — exc 0.93 V drifting down.
Put back core, exc 1.74 drifting down.
Pulled core in further, 1.93
Unplugged, exc 4.91 V.

Measured volts on ac voltmeter: red-white 3.72
- green 1.28
- black 1.85
white-green 2.48
white-black 1.85
Green-black 0.60

Plugged axial actuator lead into Ch9, voltmeter 3B17:
exc 4.90 V.

Voltages: red-white 6.19
- green 2.64
- black 4.90
white-green 3.80
white-black 1.31
Green-black 2.50

I interchanged red & black at AD connectors under 3B17
exc 2.17 drifting down.
I interchanged green & white
exc 2.17 drifting down.

Approx 1.5 MΩ to earth on all terminals under 3B17; both open circuit with 3B17 removed.
Changed yellow/brown to red.

EXC = 2:1 and drifting down, so reversing the polarity of the primary connections does not help.

Now try with TRANS-TEK 0274 LVDT.

EXC = 4.88 without core
   = 4.71 with "
   4.90 unplugged.

Try with SCHAEVITZ free LVDT, wired as before
EXC = 3.61 without core, drifting down
EXC = 4.90 with core

So these two LVDT's work in correct way.
Why doesn't the LVDT in the voltmeter?

Back to voltmeter & connected.

EXC = 4.90 without connection
   = 2.07 drifting.

So still the same.
Shelve this until alternative LVDT obtained.
To set cam in proper position, lift GREEN wire and measure AC across WHITE to BLACK, minimizing this reading.

LVDT connections to handle socket in axial actuator

Connections in the plug, looking from LVDT
AXIAL EXTERNAL LVDT again

Using the 
spare LVDT we established that to get the zero position, we have to lift the green wire & measure across WHITE to BLACK (we actually did this at the actuator end of the cable; it doesn't matter whether LVDT Black is connected to cable Black or not).

It appears that the LVDT has been positioned centrally in the DCDT space, so its centre is $(46 - 168)/2 \approx 14$mm higher than we thought. So the stem on the LVDT is now made 115mm long including the thread.

Make a new stem on LVDT core &

Set voltage on WHITE to BLACK to locate electrical zero of LVDT. Zeroed DC voltmeter output of 3817 at this position.

Then moved actuator position from 5 to 27mm & set span.

Polarity is reversed – live with that for the present.

Calibrated DC volts out against dial gauge.

Travelling down (DG going out)

\[ y = 2.5002x \quad \text{at } 0 \rightarrow 8 \]
\[ y = 2.5101x \quad 0 \rightarrow 8 \]

\(21/10/99\)

Travelling up

\[ y = 2.5104x \quad 8 \rightarrow 0 \]
\[ y = 2.4993x \quad 0 \rightarrow 8 \]

\{ Stage above POS 5 \}
\[ y = 2.4998x \quad \text{ie } 25\text{mm} = 10.001 \]
\[ y = 2.5103x \quad 25\text{mm} = 9.959 \]

\(20/4/99\)
Bottom plug was tight to get out
Wiring of QBDT load cell
20/10/99.
LVDT LOAD CELL

21/10/99

Dismantled it to replace the LVDT with open circuit secondary. Noted that the position LVDT's have excitations in series, as well as the signals. The other pairs (15 & 17) have excitations in parallel & signals in series. Stuck part in the new LVDT & soldered it up.

22/10/99

Re-set both axial & torque by adjusting core positions to give near-zero readings on AC outputs & with some zero range on the Z settings. Tried to put back plug but it was tight. Measured diameter — tapered, from 67.000 at inner end (a slightly less) to 67.020 at outer end (ie near the 0.140 Voss).

Previous measurements (pg2) were 67.000, so it appears that the plug has grown (again?). It raises the question of whether it was heat treated. Maximum pressure in the inlet was ~ 400 MPa.

Worked the diameter down with 320 paper; still touching one side (suggests two diameters concentric). Reduced again to between 0.010 & 0.020 under 67.000 (reversed taper).

Re-installed.

AT now off scale. Positioned actuator at 13.8 mm (which gives ~160 mV minimum LVDT signal). Moved 5 mm & adjusted gain.

Then ran calib of two therm vs voltage from external LVDT & set to ~10-20%.

Checking Load Cell

<table>
<thead>
<tr>
<th>After calib,</th>
<th>POS</th>
<th>IF</th>
<th>LT</th>
<th>Temp. at bottom</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instant blank</td>
<td>4.968</td>
<td>0.14</td>
<td>-12.4</td>
<td>23.1°C</td>
<td>16:43</td>
</tr>
<tr>
<td>Water cooling on (20°C)</td>
<td>15.030</td>
<td>0.11</td>
<td>-12.6</td>
<td>23.1°C</td>
<td>16:43</td>
</tr>
<tr>
<td></td>
<td>15.030</td>
<td>0.11</td>
<td>-12.5</td>
<td>23.2°C</td>
<td>16:59</td>
</tr>
<tr>
<td></td>
<td>15.031</td>
<td>0.09</td>
<td>-14.5</td>
<td>22.8°C</td>
<td>17:07</td>
</tr>
<tr>
<td></td>
<td>15.031</td>
<td>0.02</td>
<td>-16.6</td>
<td>22.2°C</td>
<td>17:23</td>
</tr>
<tr>
<td></td>
<td>15.030</td>
<td>0.17</td>
<td>-19.3</td>
<td>21.5°C</td>
<td>17:43</td>
</tr>
<tr>
<td></td>
<td>15.029</td>
<td>0.24</td>
<td>-20.8</td>
<td>21.2°C</td>
<td>18:11</td>
</tr>
<tr>
<td></td>
<td>15.029</td>
<td>0.28</td>
<td>-21.8</td>
<td>21.0°C</td>
<td>18:11</td>
</tr>
</tbody>
</table>

Note T at 20°C here.
Thermal Time Constant based on $x^2 = DT$

$$D = \frac{x}{\rho C}$$

For stainless steel, $x = 14 \text{ W m}^{-1} \text{K}^{-1}$

- Nicorros steel: 33

For iron:

- $\rho = 7900 \text{ kg m}^{-3}$
- $C = 25 \text{ J mol}^{-1} \text{K}^{-1}$

For stainless steel, $D = \frac{14}{7900.446} = 4.0 \times 10^{-6} \text{ m}^2 \text{s}^{-1}$

For Nicorros steel, $D = \frac{33}{7900.446} = 9.4 \times 10^{-6} \text{ m}^2 \text{s}^{-1}$

Thus, the approximate time constant for stainless steel is $2/D = \pi x \approx 106.8 \text{ sec}$

<table>
<thead>
<tr>
<th>Example</th>
<th>Stainless Steel</th>
<th>Nicorros Steel</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 mm</td>
<td>1 sec</td>
<td>0.4 sec</td>
</tr>
<tr>
<td>3 mm</td>
<td>2 sec</td>
<td>1 sec</td>
</tr>
<tr>
<td>5 mm</td>
<td>4 sec</td>
<td>3 sec</td>
</tr>
<tr>
<td>10 mm</td>
<td>7 sec</td>
<td>11 sec</td>
</tr>
<tr>
<td>20 mm</td>
<td>10 sec</td>
<td>43 sec</td>
</tr>
</tbody>
</table>

Thermal expansion:

Assume mismatch $\Delta l = 5 \times 10^{-6}$ over length 20 mm (approx. diff. between SS and mild steel).

Then, $\Delta T = 1K$ gives $\Delta l = 5 \times 20 \times 10^{-6} = 0.1 \text{ mm}$

Max load gives $\Delta l = 1 \times 10^{-3} \Delta$ Assume $1 \times 10^{-3}$ as maximum deflection at 50 KN for 20 mm.

- $\Delta l = 1.1 \times 10^{-3} \times 50 = 50 \mu m$

$\therefore 1K \Delta T$ gives again $\Delta l = \frac{0.1 \times 50}{50} = 0.1 \text{ mm}$ Needing $\Delta l = 10 \text{ K}$
<table>
<thead>
<tr>
<th>Time</th>
<th>Pos</th>
<th>1F</th>
<th>IT</th>
<th>Bottom Temp</th>
<th>CP</th>
</tr>
</thead>
<tbody>
<tr>
<td>21:42</td>
<td>(~18.029)</td>
<td>-0.01</td>
<td>-16.3</td>
<td>22.3°C</td>
<td></td>
</tr>
<tr>
<td>21:46</td>
<td>14.540</td>
<td>0.30</td>
<td>54.0</td>
<td>24.3°C</td>
<td></td>
</tr>
<tr>
<td>21:53</td>
<td>14.542</td>
<td>-0.02</td>
<td>79.6</td>
<td>23.1°C</td>
<td></td>
</tr>
<tr>
<td>22:01</td>
<td>14.542</td>
<td>0.44</td>
<td>105.0</td>
<td>22.6°C</td>
<td></td>
</tr>
<tr>
<td>22:10</td>
<td>14.542</td>
<td>-0.21</td>
<td>116.2</td>
<td>22.4°C</td>
<td></td>
</tr>
<tr>
<td>10:30</td>
<td>14.544</td>
<td>-0.17</td>
<td>149.5</td>
<td>22.4°C</td>
<td>18 MPa</td>
</tr>
<tr>
<td>09:54</td>
<td>14.543</td>
<td>-2.37</td>
<td>128.5</td>
<td>22.5°C</td>
<td>31 MPa</td>
</tr>
<tr>
<td>10:25</td>
<td>14.543</td>
<td>-2.98</td>
<td>126.8</td>
<td>22.4°C</td>
<td>33</td>
</tr>
<tr>
<td>11:00</td>
<td>14.543</td>
<td>-2.84</td>
<td>126.7</td>
<td>22.4°C</td>
<td>33</td>
</tr>
<tr>
<td>11:33</td>
<td>14.543</td>
<td>-2.75</td>
<td>126.7</td>
<td>22.4°C</td>
<td>33</td>
</tr>
<tr>
<td>12:12</td>
<td>14.543</td>
<td>-2.66</td>
<td>126.7</td>
<td>22.4°C</td>
<td>33</td>
</tr>
<tr>
<td>12:35</td>
<td>14.543</td>
<td>-2.62</td>
<td>127.0</td>
<td>22.4°C</td>
<td>33</td>
</tr>
<tr>
<td>12:37</td>
<td>14.567</td>
<td>-0.95</td>
<td>176.1</td>
<td>28.4°C</td>
<td>104 Pumped up</td>
</tr>
<tr>
<td>12:40</td>
<td>14.566</td>
<td>-3.20</td>
<td>120.2</td>
<td>26.2°C</td>
<td>102</td>
</tr>
<tr>
<td>12:50</td>
<td>14.564</td>
<td>-15.91</td>
<td>82.8</td>
<td>22.9°C</td>
<td>101</td>
</tr>
<tr>
<td>13:00</td>
<td>14.564</td>
<td>-16.24</td>
<td>82.2</td>
<td>22.5°C</td>
<td>101</td>
</tr>
<tr>
<td>13:12</td>
<td>14.565</td>
<td>-16.01</td>
<td>81.5</td>
<td>22.4°C</td>
<td>101</td>
</tr>
<tr>
<td>13:21</td>
<td>14.565</td>
<td>-15.89</td>
<td>81.2</td>
<td>22.4°C</td>
<td>101</td>
</tr>
<tr>
<td>13:36</td>
<td>14.565</td>
<td>-15.66</td>
<td>81.1</td>
<td>22.4°C</td>
<td>101</td>
</tr>
<tr>
<td>13:46</td>
<td>14.565</td>
<td>-15.56</td>
<td>81.1</td>
<td>22.4°C</td>
<td>101</td>
</tr>
<tr>
<td>14:18</td>
<td>14.566</td>
<td>-15.39</td>
<td>81.2</td>
<td>22.4°C</td>
<td>101</td>
</tr>
<tr>
<td>14:51</td>
<td>14.566</td>
<td>-15.25</td>
<td>81.4</td>
<td>22.4°C</td>
<td>101</td>
</tr>
<tr>
<td>15:03</td>
<td>14.620</td>
<td>-21.48</td>
<td>204.9</td>
<td>24.7°C</td>
<td>301</td>
</tr>
<tr>
<td>15:22</td>
<td>14.623</td>
<td>-19.04</td>
<td>191.0</td>
<td>22.5°C</td>
<td>300</td>
</tr>
<tr>
<td>15:34</td>
<td>14.625</td>
<td>-18.21</td>
<td>187.6</td>
<td>22.4°C</td>
<td>299</td>
</tr>
<tr>
<td>15:53</td>
<td>14.627</td>
<td>-17.43</td>
<td>184.9</td>
<td>22.4°C</td>
<td>299</td>
</tr>
<tr>
<td>16:11</td>
<td>14.627</td>
<td>-16.93</td>
<td>183.8</td>
<td>22.4°C</td>
<td>299</td>
</tr>
<tr>
<td>16:27</td>
<td>14.628</td>
<td>-16.65</td>
<td>183.3</td>
<td>22.4°C</td>
<td>299</td>
</tr>
<tr>
<td>16:46</td>
<td>14.628</td>
<td>-16.39</td>
<td>183.0</td>
<td>22.4°C</td>
<td>299</td>
</tr>
<tr>
<td>17:22</td>
<td>14.629</td>
<td>-16.05</td>
<td>182.8</td>
<td>22.4°C</td>
<td>299</td>
</tr>
<tr>
<td>17:37</td>
<td>14.630</td>
<td>-15.99</td>
<td>182.7</td>
<td>22.3°C</td>
<td>298 Droped pressure</td>
</tr>
<tr>
<td>17:43</td>
<td>14.607</td>
<td>-13.93</td>
<td>110.6</td>
<td>17.6°C</td>
<td>107</td>
</tr>
<tr>
<td>17:52</td>
<td>14.611</td>
<td>-13.76</td>
<td>111.0</td>
<td>21.9°C</td>
<td>108</td>
</tr>
<tr>
<td>18:27</td>
<td>14.611</td>
<td>-14.27</td>
<td>110.4</td>
<td>22.3°C</td>
<td>108</td>
</tr>
<tr>
<td>09:44</td>
<td>14.611</td>
<td>-14.20</td>
<td>108.5</td>
<td>22.3°C</td>
<td>108</td>
</tr>
</tbody>
</table>
Assume that linear rigidity is ~ 400 GPa with a variation of 10 GPa between SS and steel body.

\[ \Delta l = \left( \frac{\frac{p}{10^6}}{400 \times 10^9} - \frac{\frac{p}{10^6}}{410 \times 10^9} \right) \times 20 \text{ mm} \quad \text{with } p \text{ in MPa} \]

\[ = p \left( 1.22 \times 10^{-6} \right) \text{ mm} \]

For \( p = 300 \text{ MPa, } \Delta l = 0.37 \mu \text{m} \)

If FS deflection in axial force = 50 \( \mu \text{m} \), then gap shift would be \( \frac{0.37}{50} = 0.37 \text{ kN per } 300 \text{ MPa} \)
<table>
<thead>
<tr>
<th>Time</th>
<th>Pos</th>
<th>IF</th>
<th>IT</th>
<th>Bottom Temp</th>
<th>CP</th>
</tr>
</thead>
<tbody>
<tr>
<td>09:47</td>
<td>14.611</td>
<td>-14.30</td>
<td>108.5</td>
<td>22.3</td>
<td>108</td>
</tr>
<tr>
<td>09:52</td>
<td>14.573</td>
<td>-10.85</td>
<td>77.4</td>
<td><strong>bold</strong></td>
<td>33</td>
</tr>
<tr>
<td>10:16</td>
<td>14.578</td>
<td>-10.31</td>
<td>11.7</td>
<td><strong>140°C</strong></td>
<td>34</td>
</tr>
<tr>
<td>11:21</td>
<td>14.564</td>
<td>-8.07</td>
<td>82.5</td>
<td>200°C</td>
<td>34</td>
</tr>
<tr>
<td>10:07</td>
<td>14.557</td>
<td>-6.37</td>
<td>84.5</td>
<td>217°C</td>
<td>34</td>
</tr>
<tr>
<td>10:42</td>
<td>14.557</td>
<td>-5.53</td>
<td>84.5</td>
<td>223°C</td>
<td>34</td>
</tr>
<tr>
<td>10:52</td>
<td>14.558</td>
<td>-5.49</td>
<td>84.2</td>
<td>223°C</td>
<td>34</td>
</tr>
<tr>
<td>11:15</td>
<td>14.558</td>
<td>-5.44</td>
<td>84.0</td>
<td>223°C</td>
<td>34</td>
</tr>
<tr>
<td>11:36</td>
<td>14.557</td>
<td>-5.42</td>
<td>83.9</td>
<td>223°C</td>
<td>34</td>
</tr>
<tr>
<td>11:39</td>
<td>14.567</td>
<td>-5.21</td>
<td>83.0</td>
<td>196°C</td>
<td>17</td>
</tr>
<tr>
<td>11:43</td>
<td>14.570</td>
<td>-6.41</td>
<td>84.8</td>
<td>204°C</td>
<td>17</td>
</tr>
<tr>
<td>11:55</td>
<td>14.571</td>
<td>-5.25</td>
<td>91.3</td>
<td>220°C</td>
<td>17</td>
</tr>
<tr>
<td>12:08</td>
<td>14.572</td>
<td>-4.81</td>
<td>92.8</td>
<td>223°C</td>
<td>17</td>
</tr>
<tr>
<td>12:43</td>
<td>14.571</td>
<td>-4.52</td>
<td>93.3</td>
<td>224°C</td>
<td>17</td>
</tr>
<tr>
<td>12:52</td>
<td>14.571</td>
<td>-4.49</td>
<td>93.2</td>
<td>224°C</td>
<td>17</td>
</tr>
<tr>
<td>12:57</td>
<td>15.044</td>
<td>-8.56</td>
<td>78.9</td>
<td>209°C</td>
<td>0</td>
</tr>
<tr>
<td>13:05</td>
<td>15.044</td>
<td>-7.77</td>
<td>57.6</td>
<td>209°C</td>
<td>0</td>
</tr>
<tr>
<td>13:27</td>
<td>15.043</td>
<td>-7.27</td>
<td>18.8</td>
<td>222°C</td>
<td>0</td>
</tr>
<tr>
<td>13:45</td>
<td>15.012</td>
<td>-7.09</td>
<td>10.2</td>
<td>224°C</td>
<td>0</td>
</tr>
<tr>
<td>14:08</td>
<td>15.042</td>
<td>-6.97</td>
<td>4.7</td>
<td>224°C</td>
<td>0</td>
</tr>
<tr>
<td>14:35</td>
<td>15.042</td>
<td>-6.88</td>
<td>3.0</td>
<td>224°C</td>
<td>0</td>
</tr>
<tr>
<td>14:36</td>
<td>15.043</td>
<td>-4.23</td>
<td>145.8</td>
<td>225°C</td>
<td>30</td>
</tr>
<tr>
<td>14:38</td>
<td>15.044</td>
<td>-3.69</td>
<td>166.2</td>
<td>225°C</td>
<td>30</td>
</tr>
<tr>
<td>15:03</td>
<td>15.044</td>
<td>-4.34</td>
<td>131.7</td>
<td>225°C</td>
<td>30</td>
</tr>
<tr>
<td>15:22</td>
<td>15.044</td>
<td>-5.09</td>
<td>144.1</td>
<td>224°C</td>
<td>30</td>
</tr>
<tr>
<td>15:30</td>
<td>14.571</td>
<td>-2.61</td>
<td>210.8</td>
<td>28.3</td>
<td>101</td>
</tr>
<tr>
<td>15:36</td>
<td>14.569</td>
<td>-10.83</td>
<td>116.4</td>
<td>24.9°C</td>
<td>29</td>
</tr>
<tr>
<td>15:55</td>
<td>14.568</td>
<td>-19.45</td>
<td>108.6</td>
<td>22.5°C</td>
<td>98</td>
</tr>
<tr>
<td>16:16</td>
<td>14.569</td>
<td>-18.97</td>
<td>109.2</td>
<td>224°C</td>
<td>98</td>
</tr>
<tr>
<td>16:30</td>
<td>14.569</td>
<td>-18.73</td>
<td>108.3</td>
<td>224°C</td>
<td>98</td>
</tr>
<tr>
<td>16:38</td>
<td>14.626</td>
<td>-25.80</td>
<td>240.3</td>
<td>27.2°C</td>
<td>304</td>
</tr>
<tr>
<td>16:44</td>
<td>14.625</td>
<td>-24.51</td>
<td>232.5</td>
<td>236°C</td>
<td>301</td>
</tr>
<tr>
<td>16:54</td>
<td>14.627</td>
<td>-22.91</td>
<td>224.5</td>
<td>229°C</td>
<td>300</td>
</tr>
<tr>
<td>17:18</td>
<td>14.630</td>
<td>-20.95</td>
<td>218.5</td>
<td>225°C</td>
<td>298</td>
</tr>
<tr>
<td>17:30</td>
<td>14.631</td>
<td>-20.45</td>
<td>217.0</td>
<td>224°C</td>
<td>298</td>
</tr>
<tr>
<td>17:32</td>
<td>14.600</td>
<td>-15.75</td>
<td>17.3</td>
<td>139°C</td>
<td>101</td>
</tr>
</tbody>
</table>

24/10/99

- Dropped CP
- Increased CP
- Increased CP
RDP:  

<table>
<thead>
<tr>
<th>Model</th>
<th>Stroke</th>
<th>Length</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>DS/25K</td>
<td>±0.68</td>
<td>19.3</td>
<td>has plastic coil former</td>
</tr>
<tr>
<td>DS/100K</td>
<td>±2.5</td>
<td>31.7</td>
<td></td>
</tr>
<tr>
<td>MD5/500K</td>
<td>±12.5</td>
<td>68.0</td>
<td>has metal coil former</td>
</tr>
</tbody>
</table>

- Miniature unguided displacement transducers.
- Case in "magnetic stainless steel"
<table>
<thead>
<tr>
<th>Time</th>
<th>POS</th>
<th>IF</th>
<th>IT</th>
<th>Bottom Temp</th>
<th>CP</th>
</tr>
</thead>
<tbody>
<tr>
<td>17:34</td>
<td>14.601</td>
<td>-15.64</td>
<td>140.8</td>
<td>15.4°C</td>
<td>103</td>
</tr>
<tr>
<td>17:45</td>
<td>14.605</td>
<td>-15.70</td>
<td>137.2</td>
<td>21.5°C</td>
<td>104</td>
</tr>
<tr>
<td>17:58</td>
<td>14.606</td>
<td>-15.90</td>
<td>136.9</td>
<td>22.2°C</td>
<td>104</td>
</tr>
<tr>
<td>18:13</td>
<td>14.606</td>
<td>-15.97</td>
<td>136.2</td>
<td>22.4°C</td>
<td>104</td>
</tr>
<tr>
<td>18:30</td>
<td>14.606</td>
<td>-15.97</td>
<td>136.0</td>
<td>22°C</td>
<td>104</td>
</tr>
<tr>
<td>18:34</td>
<td>15.019</td>
<td>-11.9</td>
<td>30.4</td>
<td>10°C</td>
<td>25/10/99</td>
</tr>
<tr>
<td>18:35</td>
<td>15.023</td>
<td>-22.7</td>
<td>48</td>
<td>11.2°C</td>
<td>0</td>
</tr>
</tbody>
</table>

25/10/99

Changed water SP22→20

**Stirred test & took out bottom plug**

Checked dimensions of plug. Still about 0.018 below 67.000, so if there has been any growth it is not more than 0.02 mm.

Took plugs to Materials Science Lab for hardness testing:

1. Blank plug about 45 Rc

2. Active plug - too low to measure on Rc scale
   - 190 VPN, or 185 HB.

So the bottom plug had not been heat-treated! Explains that diameter is growing.

Made by Bishagen? Probably was actually Unique Tooling.
Various fitting jobs

An 8-pin socket has been fitted instead of the 10-pin socket with one blanked hole.

The max diameter (shoulder) of the socket had not been reduced to 8mm to allow the LVDT wires to pass when assembling.

LVDT wiring on SG load cell does not correspond to that on LVDT load cell.

LVDT load cell lead, viewed from back, towards transducer:

5G load cell LVDT connection, viewed from back towards transducer:

LVDT excitations in parallel; changed to being in series.
Setting up the refurbished SG Load Cell

- Had to fit the two pins in bottom of load cell body/piston.
- There are no screw holes in the strain gauge carrier to locate & hold down the LVDT carrier.
- Had to clean up the strain gauge carrier a bit more for it to fit into piston/body.
- Had to reduce the diameter of the plastic terminal block for the SG carrier to go into the piston/body.

We set the AD LVDT's in positions that correspond to those in the LVDT load cell.

<table>
<thead>
<tr>
<th>Resistance on load cell:</th>
<th>17° Bridge</th>
<th>17° Other Bridge</th>
</tr>
</thead>
<tbody>
<tr>
<td>White to black</td>
<td>262.8</td>
<td>262.8</td>
</tr>
<tr>
<td>Pink</td>
<td>350.4</td>
<td>350.1</td>
</tr>
<tr>
<td>Red</td>
<td>263.6</td>
<td>262.9</td>
</tr>
<tr>
<td>Black to pink</td>
<td>262.8</td>
<td>262.7</td>
</tr>
<tr>
<td>Pink to red</td>
<td>350.4</td>
<td>350.1</td>
</tr>
<tr>
<td>Pink to red</td>
<td>262.4</td>
<td>262.6</td>
</tr>
</tbody>
</table>

26/10/99

Back of rocket viewed away from load cell

Change Termo probe connections for input from J2-J3 to J2-J4 and put 5R resistor across J3-J4 for 4-20 mA input from EB15 and reconfigure Termo probe from 10V to 4-20mA in INSTR CONFIG, PROCESS IPS, INPUT RANGE.
Cable connection from 3B184 to the plug at back of machine, viewed from the pins (ie from 1st direction of the 12C towards the control panel).

- Red: Power
- White: Cut
- Green: Back
- Yellow: Left
- Brown: Right
- Red: SG Load cell
- White: Load cell

This goes correct since for IT but opposite for IF. Changed as shown at left. Must be turned to changed back again.

Drill two holes.
Agent whole day taping wires & sorting out connections so as to connect on to the 10-pin plug from the control units.

Seems to be a problem of signals on both axial & torsion when we push on or twist the load cell.

Installed the IC in place & in machine.

Now IF reads -10.46 & responds to both F & T.

IT: 0.4 does not respond to either.

But IF was reading ~ -590 earlier.

27/10/99

Next morning: IF: -10.57; IT: 0.4

Resistances below 3B18:

<table>
<thead>
<tr>
<th>Color</th>
<th>Value (Ω)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red/White</td>
<td>263.7</td>
</tr>
<tr>
<td>Green</td>
<td>262.8</td>
</tr>
<tr>
<td>Black</td>
<td>262.9</td>
</tr>
<tr>
<td>White/White</td>
<td>350.3</td>
</tr>
<tr>
<td>Black</td>
<td>263.0</td>
</tr>
<tr>
<td>Green/Black</td>
<td>350.3</td>
</tr>
</tbody>
</table>

Some trimming resistors are in place on for the load cell before refurbishment.

With neat weight on, IF: -10.46 7 -10.47 -10.43 -10.45 -10.38 -10.38 7 -10.38 7 -10.38 7 -10.38 7 -10.7

Nut mass: 10 kg = 100 N = 0.1 kN

No excitation or torque.

110V @ 25V OK on pins on backplane.

470Ω gain resistor in OK.

Continuity from backplane output connector to EXC terminals V & H OK. (+ to red, - to black).

POWER II on backplane is connected with S + EXC on INPUT connector.

IT 3B18 in IF slot gives 0.01 reading for neat mass.

IF: IT: no reading — no excitation.

Using the IC; EXC terminals open circuit; 10V EXC.

Plugs: 350Ω across EXC; 0.014 mV EXC.

For excitation on torsion is 1.65 Ω to earth, not for IF.

Dismantled. The short is somewhere in the neighborhood of the
Shot in item 16C/ITC for ITC

Need more convenient voltage output switching over from LVDT to SG load cells

Spring constant: 3.77 kN/mm per 100 kN

On 3818, \( \text{Gain} = \frac{200 \, k\Omega}{R_3A} \)

so to halve the gain, double \( R_3A \).

From p44, 1F balancing resistor = 330 k\Omega
1T " " 100 k\Omega
p48 1F gain resistor changed 165 k\Omega 39 k\Omega

Reversed connections for 1F below 3818, so 2 - green
3 - white
4 put resistor across 2 - 4.

Two sets of wires at back of some external connection panel, one for SG load cell, one for LVDT load cell.
ed excitation, terminal on the back of the load cell body, where the stem screws in. Wiggling the stem causes shifting. Would seem to be either on the lead going to the wedge (reddish lacquered wire) or on the heavy red wire going under the heatshrink to go up the stem. Tore out that the red wire under the heatshrink had a cut in its insulation & was coiling just up the stem. Lifted it & put a bit of epoxy underneath.

Connection to recorder:

Had to pick up on dangling wires at connection board to get the DC output from the 3B18. Did this for IF.

Setting up with spring:

The LVDT reading is approx. 8K (within 0.3%) comparing POS, 1.4 wR external LVDT.

Ran up to touch spring (with washer in place to avoid pushing on the ferrule place). TP ~ 11.6

Ran x-y record to get confirm.

28/10/99

Ran y-t record (run 1):

EF seems ok relative to spring vs AD.
IF has 0.7x more gain it should.

The 84 recorded outputs are now connected to the same banana plug (recorder output) terminals as the LVDT recorder outputs. Had to lift the LVDT output because of a small amount of pick-up.

(Put gain resistors @82.5K into IF 3B18) changed later.

Same balance resistor (330K) in IF but across 2 to 3. Changed.

Balancing resistor 100K in IF changed to 1 to 2 but it needs a smaller one. Put in 51K.

Ran y-t record (run 2) again at 0.17 Pa & took it up to 36.5 kN on EF. IF was nearly parallel but a bit of non-linearity. Very little IT reduction. Then remembered that only the inner 1.8 mm wall was being loaded instead of total wall of 1.8 + 1.2 = 3.0. So equivalent loading of inner load cell scale was about 60 kN.

Chang: gain resistor 82.5 → 150 K in IF 3B18) changed later.
Pumped up to 120 kPa.
13.4 kN shift in IF -2 kPa
-17 Nm 170

182

Changed balance resistor to 182 kΩ, ideally ~178.5, ie 9 MΩ off parallel.
Changed gain resistor to 51 kΩ.

Ran calibration at 100 kPa & 300 kPa. Around 15 kN of zero shift from 100 to 300 kPa. Calib looked similar, but may be a few percent different. Left it here.
Needs fine adjustment of balance resistor so to able to set zero adjust to range for this.

Gas far off scale on dropping pressure back below 100 kPa.
At 0 kPa, after about an hour,

\[ IF = -40.05 \]  \[ 17 = -6.4 \]
**Volumetric LVDT**

With LVDT not connected or 3B17 out, no interconnection or connections to earth 3B17.

<table>
<thead>
<tr>
<th>Connections</th>
<th>LVDT</th>
<th>Internal LVDT</th>
<th>3B17 (common)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 2</td>
<td>6.6</td>
<td>176.52</td>
<td>1.75.52</td>
</tr>
<tr>
<td>1 to 3</td>
<td>6.3</td>
<td>173.52</td>
<td>187.52</td>
</tr>
<tr>
<td>1 to 4</td>
<td>4.0</td>
<td>174.52</td>
<td>1.79.52</td>
</tr>
<tr>
<td>2 to 3</td>
<td>8.1</td>
<td>156.52</td>
<td>93.52</td>
</tr>
<tr>
<td>2 to 4</td>
<td>5.3</td>
<td>156.52</td>
<td>185.52</td>
</tr>
<tr>
<td>3 to 4</td>
<td>5.0</td>
<td>31.52</td>
<td>925.52</td>
</tr>
<tr>
<td>4 to 5</td>
<td>1.7</td>
<td>1.75.52</td>
<td>1.31.52</td>
</tr>
</tbody>
</table>

**BLACK**

**RED**

**GREEN**

**WHITE**

**EXC = 3 V**

**Tied changing to**

**EXC = 3.1 V drifting down**

**EXC = 3.0 V drifting**

**EXC = 2.86 V drift**

**EXC = 3 V drifting down**

Then this on recorder - no response for core moving out until 3 cm & when it returns. Some response in other direction.

Put the vol. LVDT on the cable to the axial ext. LVDT - gives EXC = 5.10V, normal.

Put vol. LVDT on cable to CH 9 but put in ext LVDT 3B17 — gives EXC = 5.10V, normal.
3B17 appears not to work in slot 9 but does work in slot 12 when there is no current output—disconnected current output from slot 9 did not help.

The critical factor is probably the LVDT impedance, which depends on the LVDT itself, whether its core is inserted or not, and on the excitation frequency. The earlier problems in absence of core in the axial LVDT may have been due to low impedance without the core, and the later problems with the axial LVDT due to its inherent low impedance amplified by low excitation frequency of ~1.3 kHz.

In future, should buy 3B17-03, not 3B17-00, or be more careful about ranging V ref.
Checking continuity:

Cable OK down to A Device terminals

Axial EXT LVDT in PP3817 in Ch 12 — OK
Vdr LVDT in PP3817 in Ch 12 — 3.1V EXC — bad.

Resoldered ranging resistors — seem to be OK.
Still get variable excitation.
We were able to range & zero the system but readings are drifting down as excitation drifts down.

Changed ranging card into id3 conditioned 3817, & put CH9 3817 in EXT LVDT slot.
Seemed to have vol LVDT working in EXT LVDT slot with CH9 3817, & then put 3817 back in CH9 slot & calibrated. EXC is low, drifting down & signal drifts down.

Now put on rail 3817 in slot 9 (fact DR excitation) & CH9 3817 in EXT LVDT slot.
Slot 9: EXC = 3.09 V
Slot 12: EXC = 4.91

In slot 9, rail 3817 reads -1.37 V. Gave a linear but does not change with gain. Set zero with +600. Can be adjusted to read OK over 50mm & EXC stays steady at 5 V.

In slot 12, PP CH9 LVDT gives steady EXC = 4.9 V & output is steady

Tried changing polarity by swapping yellow & brown connections (ie reversing polarity of excitation). Polarities can be reversed by reversing excitation leads.

Re-wired plug into multimeter, wired as on p. 165. EXC was again falling. Went back to the external LVDT, OK. Again connected the vol. LVDT — now EXC OK.

Further looks as if the problem is intermittent. Maybe the excitation oscillator is being overloaded. Primary impedance of the 1000 kHz transducer is listed as 100 ohm (Hence 1 kHz 1000 is 460 ohm & the Transfek was 312 ohm).
Con extension too short in volumometer.

Harmonic drive centre wrong way around in volumometer & access hole by country on top instead of bottom — corrected 66.8%.

\[ R_1 = \frac{1062 \times V}{T - V} \]

\[ R_2 R_3 = \frac{10^9}{f_{63}} \]
At 100 \( R = 2 \) mA, current would be \( 5/100 = 50 \) mA. The 3B17
book says excitation current is up to 20 mA.
If we want to stay at 20 mA, we need to increase the
impedance \( Z \) to 250I. Resistance measurement
gives 205 \( Z \) for the primary. So \( L = 98 \) for \( Z = 100 \)
\[ Z = \sqrt{100^2 - 20^2} \]

To get \( Z = 250 \) with \( L = 98 \)
we need \( R = \sqrt{(250^2 - 98^2)} \)
\[ = 230 \]

As with 205 \( Z \) already there, we used
an additional 210 \( Z \) resistance in series with the
primary in order to reduce increase \( Z \) to 250 \( Z \) to reduce
the current to 20 mA. This should be put in the
Red arm of the cable to the transducer.

However, a better way would be to custom-range the 3B17
to give 2 V excitation. This would need
\[ R_1 = \frac{10000 \cdot 2}{7} \]
\[ = 4000 \Omega \]

\[ 30/10/99 \]

Volumometer LVDT excitation still 5.09 V after running
overnight with the 'on rail' 3B17-03 15V 7.5kHz excitation.
Lifted GREEN wire & set volumometer core in electrical zero position,
the piston already being in mid-position.

Turned out that LVDT had not been connected overnight; when
connected, excitation failing. Same old problem.

Try going back to the 3B17-00 previously used 9 set to
direct voltage & higher frequency, viz:
\[ R_1 = \frac{10000 \cdot 2}{7} \]
\[ = 4000 \Omega \] for 2 V excitation (15kHz)
\[ R_2, R_3 = \frac{10^9}{7.5 \cdot 10^6} = 21000 \Omega \] for 7.5 kHz.

Now have 2.267 V excitation, OK,
but can't get core in far enough to get electrical zero.
So left off until a longer extension rod can be made.
Fixed problem with torsion speed changer - drive gear on shaft of motor was assembled upside down, bringing the teeth 1 mm further out than they should be. The new gear did not mesh with the previous one, so left it as it was with only 3 mm engagement at 180:1 - should be adequately strong enough.
Strain Gauge Load Cell in Torsion — calibration

Acting torsion actuator with φ15 calibrating bar.

<table>
<thead>
<tr>
<th>CP</th>
<th>APs</th>
<th>TP</th>
<th>IF</th>
<th>IT</th>
<th>EF</th>
<th>ET</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>12.094</td>
<td>0.699</td>
<td>-4.55</td>
<td>-1.1</td>
<td>0.8</td>
<td>20</td>
</tr>
<tr>
<td>23</td>
<td>1.777</td>
<td>0.701</td>
<td>38.49</td>
<td>-11.0</td>
<td>1.2</td>
<td>21</td>
</tr>
<tr>
<td>11</td>
<td>1.752</td>
<td>0.701</td>
<td>38.60</td>
<td>-11.1</td>
<td>1.2</td>
<td>21 after minute or so.</td>
</tr>
<tr>
<td>130</td>
<td>1.809</td>
<td>0.702</td>
<td>2.56</td>
<td>-21.3</td>
<td>2.3</td>
<td>19 soon after.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CP</th>
<th>APs</th>
<th>IF</th>
<th>EF</th>
<th>TP</th>
<th>IT</th>
<th>ET</th>
</tr>
</thead>
<tbody>
<tr>
<td>128</td>
<td>1.799</td>
<td>2.31</td>
<td>2.3</td>
<td>0.702</td>
<td>-21.3</td>
<td>19 Yaw ( \phi ) so.</td>
</tr>
<tr>
<td>125</td>
<td>1.779</td>
<td>2.39</td>
<td>2.1</td>
<td>0.702</td>
<td>-21.4</td>
<td>19 Yaw.</td>
</tr>
<tr>
<td>125</td>
<td>1.778</td>
<td>2.42</td>
<td>2.3</td>
<td>0.701</td>
<td>-21.5</td>
<td>19 ( \phi ) back ( \phi ) back ( \phi ) back ( \phi ) back Zero = -21.5 ( \phi ) ET 1623 ET</td>
</tr>
</tbody>
</table>

Axial TP = 410 mm; backed off to 3180

<table>
<thead>
<tr>
<th>CP</th>
<th>APs</th>
<th>IF</th>
<th>EF</th>
<th>TP</th>
<th>IT</th>
<th>ET</th>
</tr>
</thead>
<tbody>
<tr>
<td>125</td>
<td>3.178</td>
<td>2.42</td>
<td>2.3</td>
<td>0.701</td>
<td>-21.5</td>
<td>19</td>
</tr>
</tbody>
</table>

Torque TP = 0.704 \( \approx \) up, \( \phi \) back Zero = -21.5 \( \phi \) ET 1623 ET

Take TP \( \text{max} = 0.705 \), \( \phi \) \( \text{max} = -22.0 \), \( \phi \) ET \( \text{max} = 23 \)

For 100 Nm, we need \( \phi = \frac{100}{3787} = 0.000026 \), take 0.04 for \( \phi \)

As run TP up to 0.745

<table>
<thead>
<tr>
<th>CP</th>
<th>APs</th>
<th>IF</th>
<th>EF</th>
<th>TP</th>
<th>IT</th>
<th>ET</th>
</tr>
</thead>
<tbody>
<tr>
<td>125</td>
<td>3.171</td>
<td>3.09</td>
<td>-1.7</td>
<td>0.744</td>
<td>-56</td>
<td>46</td>
</tr>
</tbody>
</table>

At TP 0.745, we have -5.4 \( \phi \) ET -0.114 V +2.575 V

Back TP 0.704, \( \phi \) \( \text{max} = -23.0 \), \( \phi \) ET = 41 (aligned with \( \phi \) earlier)

Levelled IT volts and IT mA.

Went to 0.744 TP, should be 98 Nm and 1.96 V on ET

Max can only get ET down to 2.07 V.

Back to \( \phi \) \( \text{max} \), post changed gain resistor is 3818/17 from 470 R to 7552, gain = 2700

Need to balance bridge? 1-2 262.7

<table>
<thead>
<tr>
<th>CP</th>
<th>APs</th>
<th>IF</th>
<th>EF</th>
<th>TP</th>
<th>IT</th>
<th>ET</th>
</tr>
</thead>
<tbody>
<tr>
<td>242.7</td>
<td>2</td>
<td>263.0</td>
<td>2-3</td>
<td>265.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>262.7</td>
<td>3</td>
<td>263.1</td>
<td>3-4</td>
<td>263.1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Put \( \approx 750 \) kilo ohms \( \approx \) 3/4
For oil level indication, mount the same indicator on a strip attached to the frame as for buffer. Cut a slot in door to exit it. Need to mount oil tank higher, so that the slot does not extend to the bottom of the door.
At $TP = 0.703$, zero IT. 

Up to $TP = 0.745$ for 100 Nm torque

Act I output to +2.00 V & I output to 100 Nm & Speed

Back to zero, readjust. Repeat

Got adjustment finally at 125 MPa.

(remember that 0 on Euro man is effectively 500)

Pumped up to 294 MPa.

1F goes to 15.66, IT goes to 53.4 45.8 99.2

So calib. is still OK at 300 MPa within 1%.

31/10/99

Volumometer LVDT Again

Lot of trouble getting a stem on the LVDT core that would be ok - left it epoxyed together as temporary measure.

Found mechanical zero and set core for electrical signal by minimizing the AC signal on WHITE & BLACK with GREEN shifted.

On re-assembling volumometer, found harmonic drive centre was assembled upside down & access hole to torqueing coupling was on top rather than bottom. Corrected these.

On trying to run the volumometer with motor, two problems:

1) motor runs in a "sticky" fashion, with flickering of the fault & two green lights. Motor runs in right direction to give piston in top dead.

2) The polarity of the LVDT is opposite to required.

Switched over the excitation at LVDT (ie yellow & brown swapped)

Now motor runs normally. Changed Red into simplifies at 52.

Now appeared that polarity of LVDT opposite to required. Swapped wires back - polarity of LVDT still observed.

Do swapping get/have not change polarity??
Looking for LVDT

CCW is out (decreasing mm)

$\text{PID} = PB = 5.0 \rightarrow 1$
$TD = 60.0 \rightarrow 0$
$TI = 300 \rightarrow 0$
$MR = 0.0$

doesn't make any difference.

\[
\frac{200 \times D}{R} \cdot \frac{1}{13}
\]
Valuemeter LVDT connections now:

- RED → BLACK
- WHITE → GREEN
- BLACK → RED

This arrangement reverses the polarity — i.e., by connecting red to BLACK & black to WHITE instead of black to RED & RED to BLACK, does not reverse polarity.

Set vol pos = 0V (reads 25.005 mm) Dial Gauge: 9.30
adj to 3.996V 35.995 → 36.024 19.29
0.006V 24.967 → 25.000 9.30
1.997V 19.951 → 20.086 4.29
So LVDT appears calibrated & working.

UPSTREAM T/R: Samthread set for 4-20mA, 0-500 kPa
58C = 3.376 V 514 = 0.1 mV at 500 psi,
can scale the voltage output but can only get 514 down to 203 mV.
Gain resistor is 150Ω — changed to 200Ω.
1. Setting up pressure transducer & meter

2. Pressure testing pressure vessel

3. Setting up furnace & temp controller

4. Setting up internal LVDT's

5. Configuring IF meter & controller

6. Axial system

7. Checking axial system

8. ELC Yoke set-up & calibration

9. Axial motor tuning

10. Axial position set-up, debug & calibrate

11. Testing SG ILC

12. Torque point issue, endpoint problem – not working

13. Axial speed calibration

14. Int torque cell & LVDT problems

15. ILC problems

16. Growth of bottom plug

17. Poor fluid system

18. Decided SG ILC reject

19. Furnace testing (no. 24)

20. Assembly of LVDT load cell & testing

21. Calib. AD LVDT

22. Calib. IF on LVDT ILC

23. Axial LVDT

24. Summary of LVDT ILC AD Calib; IF Calib & check alarms

25. Calib LVDT ILC IF

26. Torque system; LVDT; calib torque & ext. torque

27. Change to single axial LVDT; re-calibrate

28. Run on Carrara marble

29. External LVDT debugging; end p. 40

30. Next visit 17/10/99
The number opposite each of the hundred years in the list below indicates which of the following calendars is the one for that year. Thus the number opposite 1994 is 7, so calendar 7 can be used for 1994.

Leap years occur in years exactly divisible by four, except that years ending in 00 must be divisible by 400 to be leap years. Thus, 1600, 1984 and 2000 are leap years, but 1800 and 1900 are not.

Easter Day is currently determined as the first Sunday after the full moon on or after March 21.

<table>
<thead>
<tr>
<th>Year</th>
<th>Leap Year</th>
<th>Year</th>
<th>Leap Year</th>
<th>Year</th>
<th>Leap Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1921</td>
<td>7</td>
<td>1947</td>
<td>4</td>
<td>1973</td>
<td>2</td>
</tr>
<tr>
<td>1922</td>
<td>1</td>
<td>1948</td>
<td>3</td>
<td>1974</td>
<td>3</td>
</tr>
<tr>
<td>1923</td>
<td>2</td>
<td>1949</td>
<td>7</td>
<td>1975</td>
<td>4</td>
</tr>
<tr>
<td>1924</td>
<td>10</td>
<td>1950</td>
<td>1</td>
<td>1976</td>
<td>12</td>
</tr>
<tr>
<td>1925</td>
<td>5</td>
<td>1951</td>
<td>2</td>
<td>1977</td>
<td>7</td>
</tr>
<tr>
<td>1926</td>
<td>6</td>
<td>1952</td>
<td>10</td>
<td>1978</td>
<td>1</td>
</tr>
<tr>
<td>1927</td>
<td>7</td>
<td>1953</td>
<td>5</td>
<td>1979</td>
<td>2</td>
</tr>
<tr>
<td>1928</td>
<td>8</td>
<td>1954</td>
<td>6</td>
<td>1980</td>
<td>10</td>
</tr>
<tr>
<td>1929</td>
<td>9</td>
<td>1955</td>
<td>1</td>
<td>1981</td>
<td>5</td>
</tr>
<tr>
<td>1930</td>
<td>4</td>
<td>1956</td>
<td>3</td>
<td>1982</td>
<td>6</td>
</tr>
<tr>
<td>1931</td>
<td>5</td>
<td>1957</td>
<td>3</td>
<td>1983</td>
<td>7</td>
</tr>
<tr>
<td>1932</td>
<td>13</td>
<td>1958</td>
<td>4</td>
<td>1984</td>
<td>8</td>
</tr>
<tr>
<td>1933</td>
<td>1</td>
<td>1959</td>
<td>5</td>
<td>1985</td>
<td>3</td>
</tr>
<tr>
<td>1934</td>
<td>2</td>
<td>1960</td>
<td>13</td>
<td>1986</td>
<td>4</td>
</tr>
<tr>
<td>1935</td>
<td>3</td>
<td>1961</td>
<td>1</td>
<td>1987</td>
<td>5</td>
</tr>
<tr>
<td>1936</td>
<td>11</td>
<td>1962</td>
<td>2</td>
<td>1988</td>
<td>13</td>
</tr>
<tr>
<td>1937</td>
<td>6</td>
<td>1963</td>
<td>1</td>
<td>1989</td>
<td>1</td>
</tr>
<tr>
<td>1938</td>
<td>7</td>
<td>1964</td>
<td>11</td>
<td>1990</td>
<td>2</td>
</tr>
<tr>
<td>1939</td>
<td>1</td>
<td>1965</td>
<td>6</td>
<td>1991</td>
<td>3</td>
</tr>
<tr>
<td>1940</td>
<td>9</td>
<td>1966</td>
<td>7</td>
<td>1992</td>
<td>11</td>
</tr>
<tr>
<td>1941</td>
<td>4</td>
<td>1967</td>
<td>1</td>
<td>1993</td>
<td>6</td>
</tr>
<tr>
<td>1942</td>
<td>5</td>
<td>1968</td>
<td>9</td>
<td>1994</td>
<td>7</td>
</tr>
<tr>
<td>1943</td>
<td>11</td>
<td>1969</td>
<td>4</td>
<td>1995</td>
<td>1</td>
</tr>
<tr>
<td>1944</td>
<td>14</td>
<td>1970</td>
<td>6</td>
<td>1996</td>
<td>7</td>
</tr>
<tr>
<td>1945</td>
<td>2</td>
<td>1971</td>
<td>6</td>
<td>1997</td>
<td>4</td>
</tr>
<tr>
<td>1946</td>
<td>3</td>
<td>1972</td>
<td>14</td>
<td>1998</td>
<td>5</td>
</tr>
</tbody>
</table>

January: T M W T F S S
February: T M W T F S S
March: T M W T F S S
April: T M W T F S S
May: T M W T F S S
June: T M W T F S S
July: T M W T F S S
August: T M W T F S S
September: T M W T F S S
October: T M W T F S S
November: T M W T F S S
December: T M W T F S S
1) FIT LVDT'S TO CARRIER (INCL. TORSION)

2) MACHINE PLASTIC CONNECTOR BLOCKS TO CLEAR LVDT'S BY 1 MM OR SO.
   (I SUGGEST LEAVING 1.6 MM THICKNESS OF PLASTIC ??)

2 OFF

6/10/80

MSP
If all wound in same sense.

Use high temperature solder.

Check out current.

6/10/00

MSP
To be done:

George - to organize making of LVDT cores
  - to fit the LVDT's to the load cell body (reaming out the holes, including for thread)
  - to machine a piece out of the plastic connector strips so as to clear the LVDT's by 1 mm or so

Sven - organize the winding of the LVDT's
  - check that the current usage is OK
  - wire up the LVDT's if possible.

Donn - assemble the LVDT carrier in the load cell body & screw the core carrier in place.
  - check the linear response of the LVDT's with a micrometer depth gauge or a good vernier caliper.
  - try to get this done by Thursday (19th)
LVDT Load Cell

Former made up as above - have to shorten in order to clear the plastic terminal block.

Dismantled LVDT/Load cell.

Unsoldered connections to former LVDT's

Position LVDT's

27

Toreured all remaining LVDT's and the test out screws in connect- strip, so removed all together without unsoldering.
Discussions on LVDT load cell.
Decided to try making two axial load LVDTs.
Prepared a drawing for George.
- Some proposal to use a strong Al alloy, but talked
  think about it on grounds of different elastic
  thermal expansion properties.
- Soon located a company that can do fine coil winding
  using 0.080 in. diameter.
- Use approx. number of windings used by Atkinson

Reading up on micro syntheses of Means, Ray, 

Some correspondence with Win Means to get a copy
of Means & Rogers.
Thought of adding some grain powder to give
a synthetic sand.
21/9/00

Did some measurements with dial gauge at ~ 90 kPa. The clumps correspond to about 0.020 mm jump each in the region x, as shown by dial gauge.

Put this assembly in a press (after the last load cycle in extension) & reproduced the clumps with the same displacements.

Dis-assembled — big screw undid very easily.
Bed burbs on screw when leaning on edge A — should be a chamfer at A but there is not.

Part D is tight on ELC, so pulled it off in the reg.

Check drawing for chamfers on part D.

Machined at 1 mm chamfer at A & also put a bit of change on lip in ELC.

Re-assembled & load to 30 kN in the hydraulic press as to seat D on ELC (there is a plate yet here). Did nut as well, as we could by hand or chamfer on a spanner on 24AF nut.

Re-assembled in reg & tested — now OK.

General:

The driven drive is a bit eccentric to the top piston — is this the cause of pick-up of the top piston which is a continuing problem (it is a bit above the miter ring).
Chart shows:

1. In three cycles, clunk behaviour is almost exactly reproduced in number & size of clunks.

2. In each clunk:
   a) EF drops back
   b) IF does not change
   c) ELVDT jumps forward
   d) LVDT does not change.

(6)(7) indicate that the friction holds the spring in some position inside when the EF drops but including the yoke & friction attachment.

(8) indicates that there is a shortening of the components between the ELVDT body & the ELC before the ELVDT body moves forward relative to the core.

There are only three junctions between the ball screw holding the ELVDT and the ELC, viz:
- The block mounted on the end of the ball screw
- The space block mounted on this.
- The ELC mounted on the space block.

The first of these is the only one where enough friction could be expected to give the hold-up before the clunk also take attachment.

The alternative way for the shortening to occur is for the ball screw or its nut to rotate, either
- the nut to jump forward (hardly likely since this would be in the direction it is being driven)
- the screw to rotate in the opposite sense to that in which it will tend to rotate due to friction in the nut.

The only other possibility is that the framework of actuator body & clunks relative to the components above the shortening:

Stick-slip in the actuator (between ball screw & yoke body) should give the upward jumps in EF, not downward. Need to check:
- nut on end of motor
- attach nut for ELC & its spacer
- centre nut in spacer & ball screw.

Put a time delay between A1C meter and deadbolt actuation to avoid door unlocking in power loss or restart while at pressure.
Clutch in the axial loading system.

From description, it appeared that during loading in one direction, there was a clunk at about 5 KN, when the displacement jumped back ~ 0.5 mm. This was reversed with nothing going in the opposite direction.

First thought was that the screws holding the Harmonic drive to the ball nut holder were not tight. However, on checking, these seemed OK. Moreover, there were multiple clunks, and some different stages before the clunks, so the situation was more less clear to me.

Decided to run more tests with better labelled chart.

Chart:
- 3 = purple = Ext LVDT 15 mm FS
- 4 = black = #E LC 40 KN FS
- 5 = blue = #RC 20 KN FS
- 6 = green = Int LVDT 3 mm FS

- Relay in the actuator signal actuator amplifier power supply jammed on (welded), and so stop. Battery did not stop the actuator. (Proximity power supply to amplifier was not interrupted) when told button released (magnet motor off while kept depressed).

- Run on spring at atmospheric pressure — only one minor clunk (but same noise on LVDT — seen once before).
- Run on spring at 75 KN.
- Observations on chart next page.
FOR CALIBRATION ONLY

# = 246 FOR RUN ONLY
# = 310 FOR COMBINED RUN/CALIBRATION

LEMO PIN CONNECTIONS
VIEW FROM THERMOCOUPLER

DO NOT SCALE

#SEC?CLASS
MATERIAL

DRAWN TO AS 1100
ALL DIM. IN mm
DIM. ACCURACY GRADE F (M) C
FINISH:

GTY

AUSTRALIAN SCIENTIFIC INSTRUMENTS

DSGN PATerson 14.95
TITLE

DRV. NAAD 17.10.96
SPECIMEN THERMOCOUPLES

CHKD

APPD

ISSUD

REV

DATE

DESCRIPTION OF CHANGE
ZONE
APPR. DATE

UNLESS SPECIFIED

1.6

SCALE 2:1 SHEET 1 OF 1

REV

DATE

DESCRIPTION OF CHANGE
ZONE
APPR. DATE

UNLESS SPECIFIED

1.6

SCALE 2:1 SHEET 1 OF 1